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A REVIEW OF BRITISH GLASSHOUSE THYSANOPTERA.

By Guy D. Morison.

(*North of Scotland College of Agriculture, Marischal College, Aberdeen*).

Manuscript received 14th February, 1957.

(Read 1st May, 1957).

With 34 text-figures.

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I. Introduction.

My aim is to summarise in this paper the knowledge of British glasshouse Thysanoptera from my observations on the insects and from a review of world literature. A key to adults is provided, sufficiently detailed to distinguish all the recorded British species, but for further details the reader should consult the references given at the end of the paper. Keys to the immature instars are not given as they would add too greatly to the length of the paper. Control by insecticides receives brief mention since it is comparatively simple and the spate of new pesticides antiquates much published work.

The thrips fauna of a glasshouse varies in numbers of species and of individuals of each species, depending on the temperature and relative humidity over a fairly long period, the species of plants grown, the time of the year and the pesticidal activities of the gardener. Many glasshouse species are very widely distributed in the world. Their bionomics have been little studied in Britain. The use of modern insecticides threatens the extermination of many species, particularly those in houses for tropical plants.

Thrips (Table I) have been introduced to glasshouses in the British Isles from tropical, subtropical and temperate countries and have had chances to multiply and to spread to other houses with the exchange of plants. The tropical and subtropical species were probably more numerous in former times when glasshouses were maintained in many parts of the country at a constant high temperature and a high relative humidity for ornamental plants. Their native countries are often unknown or a matter of doubt, but there is evidence that the insects are spread by commerce and some have established themselves out of doors in different warm countries after introduction. They

cannot survive our winter in the open and there is no evidence of their breeding out of doors. Though we lack figures of the numbers of species and of individuals of each species present in the British Isles, certain species were apparently widely distributed and common, to judge from the numbers intercepted in the U.S.A. on orchids alone from England (Swezey, 1945).

The species from warm temperate countries have been recognised in Britain within recent years. They may breed out of doors, but there seems no evidence of their overwintering in the open. They include *Taeniothrips simplex* and *Liothrips vaneeckei*.

The modern commercial glasshouse, with its seasonal crops of vegetables and flowers, is subject to frequent infestation by indigenous species (Table I), usually adapted to moderate temperatures and varying relative humidities. The insects enter by flying or walking or by carriage with plants and garden materials. They breed on plants in the open and they enter in numbers varying with the time of the year and the species of plants outside rather than inside the house. They include species that may become serious pests breeding under glass (like *Thrips tabaci* and *T. fuscipennis*), casual visitors which may breed (like *Taeniothrips atratus*) and species that enter by chance during migration or for hibernation (like *Limothrips cerealium*). Potential invaders seem fairly common in at least the southern half of England and, as all occur on the continent of Europe and most in N. America, there is a possibility of their introduction from abroad.

II. List of Species of British Glasshouse Thysanoptera.

British glasshouse Thysanoptera may be divided into two groups—one Introduced Species and the other Indigenous Species, and each group may be subdivided into two sections, the first to include those recorded from glasshouses and the other potential invaders. The species concerned are listed in Table I and are discussed below in the text. All are Thripidae except the Phlaeothripids, *Aleurodothrips*, *Haplothrips* and *Liothrips*.

III. Collection, Preservation, Examination.

The collection of thrips is easy. Special methods of collecting and estimating the numbers on plants have been described by McGregor (1926), Evans (1933), Le Pelley (1943), Hoerner (1947), Schirck (1948) and Taylor and Smith (1955).

After being picked or beaten off a plant the insects may be placed in a tube containing 50 per cent. methanol or ethanol in water mixed with 0·5 per cent. by volume of ethyl acetate. The mixture macerates them and renders adults comparatively easy to spread out in the mountant, but it is not suitable for preserving specimens for more than a few days at the usual room temperature (60–65° F.). For long storage the insects should be kept in 80 per cent. ethanol in the dark. With the insects the tube should contain a label with the finding-place, which is the species of plant or the object on which the insect was found, locality, date and collector's name. Thrips are mounted in one of the microscope mountants on glass slides, with the dorsal side up and with the antennae, wings and legs spread out. Some of the specimens may be mounted upside down or sideways to show characters better seen in these positions. For permanent mounts a resinous medium seems most suitable. I use Sira mountant or Canada

TABLE I.—*British glasshouse Thysanoptera.*

(*The figures indicate the number of the illustration*).

Species from abroad.

Recorded from glasshouses.	Potential invaders.
1. *Heliothrips haemorrhoidalis*	5. *Caliothrips fasciatus*
2. *Hercinothrips bicinctus*	*Asprothrips raui*
3. *Hercinothrips femoralis*	*Anaphothrips* spp. } on orchids
4. *Helionothrips errans*	*Neophysopus* spp. } on orchids
6, 7. *Parthenothrips dracaenae*	*Dichromothrips*
9. *Scirtothrips longipennis*	17. *Taeniothrips xanthius*
Leucothrips nigripennis	*Taeniothrips dianthi*
15. *Neophysopus orchidaceus*	32. *Haplothrips subterraneus*
16. *Chaetanaphothrips orchidii*	33. *Aleurodothrips fasciapennis*
Chaetanaphothrips sp. Speyer and Parr	
20. *Taeniothrips simplex*	
31. *Scolothrips*	
34. *Liothrips vaneeckei*	

Species indigenous to Britain.

Recorded from glasshouses. Casuals except those marked *.	Potential invaders.
11. *Limothrips cerealium*	8. *Dendrothrips ornatus*
13. *Aptinothrips rufus*	10. *Drepanothrips reuteri*
14. *Anaphothrips obscurus*	*Limothrips denticornis*
18. *Taeniothrips picipes*	12. *Iridothrips iridis*
19. *Taeniothrips atratus**	25. *Thrips angusticeps*
21. *Taeniothrips vulgatissimus*	29. *Parafrankliniella verbasci*
22. *Thrips fuscipennis**	*Aptinothrips stylifer*
23. *Thrips major**	
24. *Thrips tabaci**	
26. *Thrips flavus*	
27. *Thrips nigropilosus*	
28. *Frankliniella intonsa*	
30. *Kakothrips robustus*	

balsam or Euparal. The method used should not distort the segments nor remove the pigments which are useful in classification. Coloration is judged from adults and larvae examined under a microscope by transmitted light and then by reflected light, with first a matt white and finally a black paper background. Either the white or the black background shows up coloration easily overlooked during examination by transmitted light.

IV. ADULTS, METAMORPHOSIS, IMMATURE STAGES.

Thysanoptera are divided into two suborders : (1) Terebrantia, in which the female has an exsertable, serrated, blade-like ovipositor used to place the delicate-shelled egg inside the superficial tissue of plants, two larval, one prepupal and one pupal instar ; (2) Tubulifera, in which the female lacks a blade-like ovipositor (the hard-shelled eggs being laid on the surface of plants), and has two larval, one prepupal and two pupal instars.

Adults.

Adult glasshouse thrips may measure between 0·9 and 2·5 mm. in length. Females are usually more numerous, larger and darker than males. In Terebrantia the sex can generally be distinguished in the field by the naked eye from the size, colour, activity and the more or less pointed apex of the abdomen of the female (fig. 11) which contrasts with the rounded apex of the abdomen in the male (fig. 7).

According to the species the wings may be hyaline or shades of grey or brown or, more rarely, banded or striped with hyaline (appearing white when dry) and dark coloured areas. Each wing has a small posterior expansion, often scale-like, of its base. It is convenient to use the terms *macropterous* for thrips with fully developed wings, *hemimacropterous* for those with wings intermediate between full development and scale-size, *micropterous* for those with scale wings, and *apterous* for those which never had wings.

Metamorphosis.

The first instar larva, conveniently denoted by the Roman numeral I, is generally pale yellow or almost white, with the body more or less translucent. The second instar larva (II) differs in various anatomical details from the first and is generally more opaque and darker. The colour of the food in the alimentary canal can often be seen through the body-wall. The prepupa and pupa (pp. 472) bear the general coloration of the larvae, which darkens as the adult matures within the pupal cuticle; this process is probably affected by the environment of the pupa and, later, of the newly emerged adult. Nevertheless, the adult on emerging from the pupa is pale, sometimes pale yellow shaded with grey, before it becomes dark brown or almost black with age. The change in coloration can be observed quite easily in captive specimens. Hibernating females of certain species become very dark. The change in coloration of the individual and its variation within the species have led to some of the colour variations being given names, *e.g.* Pomeyrol (1928) showed that var. *abdominalis* Reuter is a young female that has yet to acquire the darker coloration of *Heliothrips haemorrhoidalis* (Bouché).

Eggs (Priesner, 1926; Morison, 1947).

The female Thripid uses her ovipositor to make a slit in the superficial cells of the soft plant tissues in which she lays an egg, which is cylindrical, usually slightly curved, with both ends rounded, and has a thin colourless shell and whitish or yellowish contents. The long axis of the egg lies more or less oblique to the outer surface of the plant with the head-end projecting slightly, so that the developing larva faces the exterior to which it climbs on hatching. The hard-shelled phlaeothripid egg is often sculptured and faintly coloured, and is straightly cylindrical, rounded at the bottom and tending to be more constricted at the top, which may bear a knob. The eggs are laid amongst flowers, leaves, fungus under bark; often the egg rests with the long axis horizontal to the support. Depending on the species, the eggs measure 350–550 μ in length and 130–250 μ in width (in the Thripidae a little less). According to species, temperature and other factors, the egg stage lasts 2–20 days or longer. The larva emerges from the anterior end, leaving about two-thirds of the shell embedded in or fixed to the plant. The emergence hole is more or less circular but with an irregular margin.

Facultative viviparity has been discussed by John (1923) for certain Phlaeothripids but I have found no proof of its occurrence in Britain.

Larva (Priesner 1926, 26–28 ; Speyer and Parr, 1941 ; Morison, 1947).

Instar I.—When newly hatched it is 0·25–0·5 mm. long, almost transparent but showing the coloration and other characters of its species. It feeds on plant juices, the stage lasting a few days ; fully grown it measures about double the length when first hatched, and seeks a sheltered place on or near the host plant to moult.

Instar II.—Emerging from the cuticle of I pale and soft, it soon becomes darker and tougher, differing from I in greater size, coloration, cuticular structure, chaetotaxy and relative lengths of certain bristles, and in the shape of the antennal segments. When full grown it is about as large as the adult thrips. The duration of this stage varies according to species and environment from two to three days in *Thrips tabaci* in summer to some months in overwintering *Kakothrips robustus*, and six to eight months in many species of overwintering Phlaeothripids. The sex cannot be distinguished externally except that the males are generally smaller. Pupation occurs on the plant or amongst soil and debris according to species and environment.

Prepupa and pupa (Priesner, 1926–28 ; Morison, 1947).

The prepupa is followed, after emerging from the cuticle of II, by one pupal instar in the Terebrantia and two in the Tubulifera. Neither the prepupal nor the pupal instars feed, but they can walk slowly and they avoid light. The two or three instars are usually passed in the same place. The prepupal stage lasts only a few days. In the Thripidae the antennae are held straight in front of the head and their segmentation is obscure ; wing-sheaths are short, and ovipositor sheaths are present on the ventral surface of abdominal segments VIII and IX of the female.

In the pupa the antennae are turned back over the prothorax, the wing-sheaths are long, and the ovipositor sheaths large ; the apex of the abdomen is pointed in the female, rounded in the male. The pupal environment in the soil has been studied by MacGill (1927, 1930, 1930*a*) for *Thrips tabaci* and by Andrewartha (1934) for *T. imaginis* Bagn.

V. Parthenogenesis.

This has been described by Buffa (1911), Shull (1914*a*, 1917), Pomeyrol (1928), Pussard-Radulesco (1930, 1931), Vandel (1931), Capelletto (1933), Sharga (1933*a*), Callan (1943*a*), Suomabanien (1950) and Bournier (1956). It seems to be affected by environment, season and geographical region and occurs constantly in many species introduced from warm or hot climates to this country, where they breed in glasshouses (Table II). It should be studied for each species, for if it occurs sporadically in a species the irregular appearance of males could easily be interpreted in the absence of properly controlled breeding experiments as due to a non-parthenogenetic race living with a parthenogenetic race.

Parthenogenesis does occur, though less commonly than is shown in Table II, amongst species indigenous to Britain, and usually breeding in the open and occurring in large numbers. The proportion given below of females to males is based on my observations during many years. As the females of some species

TABLE II.—*Proportion of females to males. Thripidae.*

Species.	Females.	Males.
Heliothrips haemorrhoidalis	Numerous	Only 1 recorded, *cf.* Bournier (1956).
Hercinothrips bicinctus	Common	Not recorded. I have 1 from New Zealand.
Hercinothrips femoralis	Numerous	Not recorded in Britain. *See* Eide (1943) and Bailey (1933) for proportion of sexes in glasshouses in U.S.A.
Helionothrips errans	Common	1 described from Formosa. 1 from Kenya (*mihi*).
Caliothrips fasciatus	,,	Scarcer.
Parthenothrips dracaenae	Numerous	In colder glasshouses.
Scirtothrips longipennis	Common	Not recorded.
Leucothrips nigripennis	,,	,, ,,
Anaphothrips orchidaceus	,,	Scarcer.
Chaetanaphothrips orchidii	,,	Not recorded.
Taeniothrips simplex	,,	Scarcer.
Taeniothrips xanthius	,,	Seldom recorded. Cory (1941), 3 ♀, 1 ♂.

live much longer than the males, they may be found more frequently than the latter. The social behaviour of each sex has to be considered for each species in estimating numbers from observations in the field. The sexes seem to occur in about equal numbers or with a predominance of females in Britain in *Limothrips cerealium*, *L. denticornis*, *Taeniothrips atratus*, *Thrips fuscipennis*, *T. major*, *T. flavus*, *Frankliniella intonsa* and *Kakothrips robustus*. However, the numbers of one sex (usually the male) may be reduced, *cf.* Buhl (1936) for *Kakothrips robustus*. In *Taeniothrips vulgatissimus* the sexes occur in about equal numbers in Scotland, but males become scarcer in north and rare or absent in south England, where the females are scarcer than in Scotland. The greater proportion of males is perhaps correlated with the colder climate of Scotland, for by tracing the records of the insect through Europe it is found that both sexes occur in abundance in the colder regions, the male becoming scarcer in warmer places and often not being recorded with females from still warmer regions. Under glass *Thrips tabaci* seems always parthenogenetic, and out of doors in Britain and other countries of its cosmopolitan distribution it is usually so, but both in Britain and abroad males may appear locally in varying numbers. Harris, Drake and Tate (1936) mention its sex ratios and parthenogenesis in Iowa, and Shull (1914) discusses its parthenogenesis. From my observations it appears that its sexes occur in about equal numbers when it lives in a warm, dry climate. I have found about 150 ♀ to 1 ♂ for *Aptinothrips rufus* in N.E. Scotland. Males have not been recorded in Britain for the common species *Anaphothrips obscurus* and *Thrips nigropilosus*.

VI. BIONOMICS, BEHAVIOUR STUDIES.

Adults and larvae are chiefly diurnal in their activities, except for certain partly crepuscular Tubulifera and some species living in subdued light inside galls. Males are generally smaller than females and more active in walking and starting flight. Predacious species tend to walk more rapidly than vegetarian species. Either sex walks but a short distance and then stops. The antennae keep flickering in front of the insect, apparently to sense the immediate

environment. Certain species are capable of jumping about 1 cm. high and this capability may be associated with wings fully developed, reduced or undeveloped. The jump is often preliminary to flight—the insect starting to spread its wings before jumping and then apparently opening them fully in the course of or at the end of the leap. There seems no external morphological indication that the insect can jump, though Hood considered that some jumping species have the posterior coxae more closely placed than in an allied non-jumping species. Thysanoptera are not strong fliers, though the females of certain species like *Limothrips cerealium* may travel quite considerable distances with the help of the wind when seeking winter quarters or larval host plants. Flight is probably important for the distribution and maintenance of many species, but distribution may be influenced by other factors than flight, for the apterous *Aptinothrips rufus* is almost as widely spread through the continents as the macropterous *Thrips tabaci*. There is no record of the introduced species flying in British glasshouses nor have I seen any of the indigenous British species doing so, though Speyer (1939) mentions it for *Thrips fuscipennis*. From my observations it seems that the stimuli for flight are fairly high to high temperature, lack of strong wind, probably a fairly high intensity of light and usually a low degree of relative humidity acting on the insect at a particular state of sexual development.

The responses to physical and chemical stimuli have been little studied. Amongst those species which live under bark or in galls or between the leaf-sheath and the stem of grasses, thigmotaxis, or the positive contact reflex, seems well developed but it has not been critically studied. It is not exhibited by any instar of *Heliothrips haemorrhoidalis* and *Parthenothrips dracaenae* which breed on the surface of plants in shade in a constantly warm, still atmosphere with a high degree of relative humidity, but it is strongly displayed by all instars of *Limothrips denticornis* living on Gramineae in the open and subject to considerable desiccation by sun and wind and displacement by wind and rain. This suggests that it has been evolved in a species as protection against factors such as desiccation, excessive moisture, light, displacement by wind and that it will be associated with other reflexes. The winged females of *L. denticornis* show it least during the course of their migrations to or from the larval host plant. In *Thrips tabaci* and many other species it is most strongly shown by the adult, larva II, prepupa and pupa, the last two stages being usually spent in the litter and soil beneath the host plant (*cf.* MacGill, 1927, 1929, 1930, 1930*a*, 1931; Wardle, 1927; Andrewartha, 1934).

We do not know what organs sense odorous chemicals, but they are probably certain trichomes, cones and tympanic areas on the antennae. Howlett (1914) found in India that benzaldehyde, cinnamylaldehyde and anisaldehyde, mixed with water and exposed in bowls, attracted numbers of two unindentified species of Thripids which were drowned in the water. He suggested that these chemicals may provide a simple method of destroying the insects in quantity. The benzaldehyde and water trap has been used in the open for the thrips in Indian tea gardens by Andrews and Tunstall in 1915, but the insects were not named specifically. Morgan and Crumb (1928) observed, in an oatfield in Tennessee infested with *Limothrips cerealium* and *Frankliniella tritici* Fitch, that the insects were attracted to the following chemicals (listed in order of diminishing attractiveness): cinnamic aldehyde, salicylaldehyde, anisic

aldehyde, benzyl alcohol, cinnamyl alcohol, benzaldehyde, nitrobenzoic acid (ortho), nitrobenzene, nitrobenzaldehyde (ortho), nitrobenzoic acid (meta), oil of bitter almonds (true).

According to species, adults and larvae feed on the contents of the cells of vascular plants or on fungi, or one or both stages may suck the juices of small Arthropoda. The fungus feeders are absent from glasshouses in Britain, probably through lack of proper fungi, nor are there predacious species, for *Scolothrips* failed to establish itself after its introduction from California by Speyer for the control of red spider mite, and *Aleurodothrips* is not recorded as established in Europe, whilst the British predacious species seem not to enter glasshouses, though I have found *Aeolothrips fasciatus* and *A. tenuicornis*, whose II instar larvae are predacious on small Arthropoda, not uncommonly on outdoor plants touching glasshouses in England. Of the phytophagous thrips some breed on only one species of plant, others on the species of a single genus or of closely related genera, and others on many species belonging to many families. Most of the glasshouse species belong to the second or third category. Adults of a certain species may breed on several species of plants, feed upon these and others, and frequent yet others. I have found *Taeniothrips atratus* on more than 478 species of plants in the British Isles as well as on various inanimate objects. A species of plant that serves for rearing larvae of a species of thrips I call a *host plant* of that species. The plant or object on which the insect is found may be called the *finding place*. The finding place may happen to be the host plant, but too often it has been so called without any proof that the insect feeds or breeds on it.

Glasshouse species tend to feed on the undersurface of leaves or on the sides of stems in an inverted or more or less vertical position. After the mouthparts have abraded and punctured the walls of a few of the external layers of cells, the cell contents are sucked up by the insects, who are probably aided in this by the natural welling up of the juices through differences in turgor between damaged and undamaged cells (*cf.* Borden, 1915; Wardle and Simpson, 1927). The attacked surfaces of leaves, green stems and petals are marked by a silvery sheen, due largely to air occupying the cell cavities from which the insects have removed the normal contents of protoplasm and fluid. Faeces are deposited on or near the attacked surface in the form of a small volume of coloured and a much larger one of colourless, watery matter. The drying faeces may become dark coloured through the invasion of brown fungi. The larvae of *Heliothrips haemorrhoidalis* and closely allied species have the habit of collecting quite a large globule of faeces at the end of the body before depositing it on the plant. Leaves attacked by them tend to become more speckled with brown fungi than those attacked by *Thrips tabaci*.

Visible damage tends to be localised on the plant owing to the gregarious habits of the adults of many species and because the larvae do not wander far from the food plant on which they are born in some numbers. The damage, particularly to flowers in the open, may be caused by adults of one or both sexes of one or more species, or by adults and larvae of a single species, for it is seldom that adults and larvae of two or more species attack the same portions of a plant simultaneously. Adults are found on more species of plants than larvae. If larvae pass from host plant to soil for pupation they may occur on plants which are not hosts but which happen to lie in the way.

Long sustained attack may result in considerable damage to ferns, cacti, palms, *Lapageria*, *Dracaena*, and other plants. Glasshouse plants seem not to have been bred for resistance, but Bailey (1941) describes results of experiments on breeding vegetables for resistance to insects, including thrips ; Callan (1943) carried out similar experiments on Cacao.

Adults of some species that visit flowers become quite thickly coated with pollen and so may help in the fertilisation of flowers, but there is little experimental evidence that they actually do so.

When a species like *Thrips tabaci* transmits a virus disease, no recognisable attack may be present before the disease appears. Comprehensive accounts of the role of thrips in the transmission of virus diseases have been written by Bailey (1935), Smith (1937), Jensen (1945) and Sakimura (1947).

No elaborate courtship exists ; the male climbs on the back of the female with his head facing the same way as hers ; if she does not shake him off copulation may be completed within a few seconds. The sexes are promiscuous within the species. According to Pussard-Radulesco (1931) the male *Limothrips denticornis* fertilises the female pupa, not the adult female. Depending on the species and season, oviposition may start within a few days of fertilisation (summer generation), or some months after it (overwintering females) and, as remarked above, in many species parthenogenesis prevails. The possible progeny of a female seems to average 30–50. Longevity from new laid egg to death of adult female is 1–12 months or longer, depending on the species and season.

Amongst indigenous British thrips winter is passed by the adult female or both sexes or the mature larvae or a combination of one or both sexes of adults and larvae, depending on the species. The number of generations out of doors varies from one (*Kakothrips robustus*) to two (*Taeniothrips atratus*, *Thrips tabaci*), though the last may have six or seven in the south of France and 12 under glass. Generations overlap owing to the comparatively long life and oviposition period of the female, and the short time needed for the development of the summer generation, and to the fact that the adults of any one generation become mature at different times. Evans (1933*a*, 1935) describes the seasonal fluctuations in numbers of *Thrips imaginis* Bagn. and certain associated blossom thrips in Australia. I have noticed annual variation in numbers of some British species in the open over a long period.

Gregariousness is common, its causes being assembly for fecundation, food, oviposition, shelter or in temporary resting places between host plant and the soil. Hundreds of insects may congregate within a square foot of flower or leaf surface. Fecundation usually seems the reason for the assembly of both sexes of the " flower thrips " *Thrips fuscipennis*, *T. major*, *T. flavus*, *Taeniothrips atratus* and *Ta. vulgatissimus* on flowers that are often not those of larval host plants.

Weather is a big factor affecting the behaviour and control of thrips (*cf.* MacGill, 1931, 1937). Drought allows numbers of adults and immature instars to survive, whilst rain tends to wash them off the plants and constantly high relative humidity favours the spread of fungal parasites.

Adult and larval Terebrantia and many Tubulifera pass the night and wet weather sheltered inside flowers or on the lower surface of petals and leaves.

VII. Associates and Enemies.

Thrips very seldom occur on plants supporting numerous Psyllidae, Aleyrodidae, Aphididae or Coccidae and then only in very small numbers, perhaps because of the excretions spread on the plants by these insects. Fungi which develop in these excretions or which cover plants are generally avoided, but Yarwood (1943) should be consulted for the association of thrips with powdery mildews. There seems no association with ants or red spider mites.

Human control of thrips is so efficient and rapid that there is little chance of predators and parasites establishing themselves conspicuously. The predacious *Scolothrips* did not become established after introduction to England by Speyer (1938). There seems no record of parasitic Hymenoptera in British glasshouses, though they have been recorded from other countries. We lack evidence of any species of ants affecting populations of thrips. Spiders and the mite *Anystis baccarum* (L.) are likely to kill a few thrips. MacGill (1939) has described a Parasitid (Gamasid) attacking thrips. Fungi developing in the body cavity kill many adults and larvae of different species in the open and I have found *Parthenothrips dracaenae* attacked and killed by fungus in glasshouses.

VIII. Rearing.

The following papers deal with life-histories and methods of rearing: Bailey (1932, 1933), Buhl (1934), Callan (1947), Hodson (1935), Rivnay (1935), Sharga (1933) and Williams (1915).

IX. Key to Genera of British Glasshouse Thysanoptera.

(Females, most males).

1 (50) Female with saw-like ovipositor developed from ventral surface of abdominal segments VIII and IX; in the female abdominal segment X usually conical, rarely tubular, and divided lengthwise along the ventral surface (fig. 11); in the male abdominal segment IX usually abruptly rounded, never tubular and bears dorsally the reduced segments X and XI (fig. 7); wings with microtrichia on the surface and hairs on the veins and long cilia fringing the posterior margins; fore wing with an anterior marginal vein and at least one long vein reaching or almost reaching the apex
Sub-ord. **Terebrantia** Haliday

2 (3) Ovipositor in retracted position curved upwards (backwards); wings broader, rounded at apices . Fam. Aeolothripidae Uzel

3 (2) Ovipositor curved downwards (forwards); wings narrower, pointed at apices . . . . . [Fam. Thripidae Uzel]

4 (14), (19), (26) Upper surface of body more or less covered with distinct polygonal reticulations (figs. 1–7); fore wing with curved hind margin; terminal antennal segments exceptionally long, often needle-like (figs. 1–6).

5 (12), (13) Antennae 8-segmented, the last 2 segments forming the style.

6 (9) Head lacking raised transverse ridge near base; pronotum without lateral margin projecting as a ledge (fig. 1).

7 (8) Fore wings pale, considerably broadened at base; no strong bristles on costa; legs pale yellow . . . . **Heliothrips** Haliday

8 (7) Fore wings dark with 2 transverse paler bands, apex dark; strong bristles on costa and second long vein; 2 short bristles near fork and 2 near apex of first long vein; legs banded brown and yellow . . . . . (not British) **Caliothrips** Daniel (*Hercothrips* Hood)

9 (6) Head with raised transverse ridge near base; pronotum with each lateral margin projecting as a narrow ledge.

10 (11) Fore wing pale with 2 dark cross bands, apex pale; bristles as long as or longer than width of wing present on costa, first and second long veins. . . . . **Hercinothrips** Bagnall

11 (10) Fore wing pale brown with 2 paler cross bands, apex brown; bristles short (about half width of wing), present on costa, base and apex of first vein and over basal two-thirds of second long vein . . . . . **Helionothrips** Bagnall

12 (5), (13) Antenna 7-segmented, style 1-segmented . . . **Parthenothrips** Uzel

13 (5), (12) Antennae apparently 9-segmented owing to false partition across segment VI. (cf. *Dendrothrips* Uzel).

14 (4), (19), (26) Upper surface of head and sides of abdominal tergites with fairly prominent polygonal reticulation; body broad and flat; fore wing with a straight hind margin.

15 (18) Pronotum without strong bristles near hind angles.

16 (17) Antennae apparently 9-segmented owing to false partition across segment VI (fig. 8) . . . . . **Dendrothrips** Uzel

17 (16) Antennae 8-segmented, segments V–VIII closely united; wings narrow . . . . . (not British) **Asprothrips** Crawford

18 (15) Pronotum with one strong bristle near each hind angle **Monochaetella** Priesner

19 (4), (14), (26) Most or all abdominal tergites bearing dorsally and laterally exceedingly fine hair-like cuticular processes; microtrichia, lacking cell-like sockets and only visible under high magnification (fig. 10); sclerites without conspicuous reticulation, but usually more or less covered with numerous fine confluent transverse striae; fore wings with curved hind margin.

20 (21) Antennae 6-segmented; fore wing with 2 long veins (fig. 10) **Drepanothrips** Uzel

21 (20) Antennae 8-segmented.

22 (23) Pronotum with 2 long bristles on posterior margin near each hind angle; body pale yellow, microtrichia scanty; maxillary palpi 2-segmented . . . . . **Leucothrips** Reuter

23 (22) Pronotum with 2 shorter bristles on posterior margin near each hind angle and one longer and stronger on either side nearer the middle line (fig. 9).

24 (25) Abdominal tergite IX with a transverse row of 6 dorsal bristles besides the postero-marginal row of bristles; body dark brown and microtrichia very dense on abdominal segments I–VIII; fore wing with first long vein bearing 15–25 bristles and the second represented by 1 (rarely 2) bristles near apex, but wings often micropterous without this arrangement of bristles . . . . . **Sericothrips** Haliday

25 (24) Abdominal tergite IX with a pair of dorsal bristles besides the postero-marginal row; body yellow; microtrichia not very dense; fore wing with first vein bearing 3–2 bristles in basal half and 3 widely separated in apical half and the second vein

represented by 3–5 bristles evenly spaced along the whole of its length (fig. 9) . . . . **Scirtothrips longipennis** (Bagnall)

26 (4), (14), (19) Upper surface of body not covered with distinct polygonal reticulations, at most with confluent transverse striae; microtrichia not scattered on abdominal tergites; fore wing with curved hind margin and 1 or 2 long veins; pronotum with or without long bristles (figs. 11–31); larvae varied in structure.

27 (30) Head produced in front of eyes into a projection upon which the 8-segmented antennae are inserted; body dorsoventrally flattened; fore wing with 2 long veins.

28 (29) Head produced into a pentagon in front of the eyes; females usually macropterous, males apterous; abdominal segments VIII and X or VIII, IX, X in female, each bearing 1–2 pairs of extra stout bristles (fig. 11). . . . **Limothrips** Haliday

29 (28) Head broadly rounded in front of eyes; both sexes with various degrees of wing development; pronotum with 1 long bristle at each fore angle and 2 longer bristles on posterior margin near each hind angle (fig. 12) . . . . . **Iridothrips** Priesner

30 (27) Head not or only slightly produced in front of eyes; body not specially flat.

31 (38), (39), (44), (45), (49) Pronotum without any strong bristles.

32 (35) Ocelli absent; wings absent; body usually narrow.

33 (34) Antenna 6-segmented (no style) (fig. 13) . . **Aptinothrips** Haliday **rufus** Hal.

34 (33) Antennae 8-segmented (style 2-segmented) **Aptinothrips stylifer** Trybom

35 (32) Ocelli usually present, but may be represented merely by spots of pigment; wings present or reduced, when present each fore wing bears 2 long veins; body broader.

36 (37) Antennae apparently 9-segmented owing to false partition across segment VI (fig. 14); macro- or micropterous **Anaphothrips** Uzel

37 (36) Antennae 8-segmented, style (2-segmented) shorter than segment VI (fig. 15); wings usually present, at least in females . . . . . **Neophysopus** Schmutz

38 (31), (39), (44), (45), (49) Pronotum with 2 strong bristles, one on hind margin near each hind angle. *Body dark brown with abdominal segments II–VI pale yellow; fore wing with* 2 *wide dark cross bands; first vein with* 3 *distal bristles, second vein with* 13–16 *bristles* (not British) **Dichromothrips** Priesner

39 (31), (38), (44), (45), (49) Pronotum with 4 strong bristles (though they may be short), 2 on hind margin near each hind angle. *Fore tibia unarmed; first long vein of fore wing rarely set throughout its length with bristles; antennal segment VI with small sense cones which are not lancet-shaped or scale-like.*

40 (43) Antennae 8-segmented.

41 (42) Body yellow; fore wing with 2 wide dark cross bands; first vein with about 3 distal bristles, second vein with about 4 bristles; pronotal bristles short (fig. 16). **Chaetanaphothrips** Priesner

42 (41) Body varies from pale yellow to brown or almost black depending on the species and partly on the age of the insect; fore wing with 1 or no dark cross band; chaetotaxy different from above, but wings may be reduced or absent in one or both sexes, depending on the species; pronotal bristles usually longer (figs. 17–21) . . **Taeniothrips** Amyot and Serville
cf. *Thrips* L.

43 (40) Antennae 7-segmented . . . . . **Thrips** L.

44 (31), (38), (39), (45), (49) Pronotum with 6 strong bristles, 1 on front margin near each fore angle and 2 on hind margin near each hind angle
cf. **Iridothrips** Pr.

45 (31), (38), (39), (44), (49) Pronotum with 8 strong bristles, 2 on fore margin and 2 on hind margin near each angle.

46 (47), (48) Long pronotal bristles near fore and hind angles about equal in length (fig. 28) . . . . . **Frankliniella** Karny

47 (46), (48) Inner pronotal bristle about twice as long as outer near each fore angle (fig. 29) . . . . . **Parafrankliniella** Priesner

48 (46), (47) Outer bristle longer than the inner near each fore angle. *Abdominal segment VIII in male on either side with a short process curved backwards and upwards over the spiracle; these processes reduced but distinguishable in the female* (*fig.* 30)
Kakothrips Williams

49 (31), (38), (39) (44), (45) Pronotum with 12 strong bristles, 2 on front margin near each fore angle, 1 on each side margin and 6 along posterior margin (fig. 31) . . . . . **Scolothrips** Hinds

50 (1) Female without ovipositor; abdominal segment X in both sexes closed below, usually tubular; wings without microtrichia on the surface or a long series of hairs on the veins, but fringed all round with long cilia; fore wing with only 1, usually simple, shortened central vein . Subord. **Tubulifera** Haliday

— Maxillary palps 2-segmented; antennae 8- rarely 7-segmented; middle coxae further apart than fore and hind coxae; abdominal segment IX not or rarely longer than VIII; terminal bristles of the abdomen seldom much longer than the tube (abdominal segment X) . Fam. Phlaeothripidae Uzel

A (B), (C) Head about as long as wide, about 1·5 times length of pronotum and of tube, about twice length of mouth-cone, which is broadly rounded at the apex; antennal segment III more or less asymmetrical in dorsal view; fore wings constricted in middle, sole-shaped; fore femur enlarged in both sexes (fig. 32) . . . . . **Haplothrips** Amyot and Serville

B (A), (C) Head about as long as wide, little longer than the mouth-cone, which is broadly rounded at the apex; fore wings broad at base, narrow in middle and slightly broader near apex, grey-brown with 3 hyaline cross bands; fore femur with spur on inner surface, weak in female, large in male (fig. 33)
Aleurodothrips Franklin

C (A), (B) Head about 1·4 times longer than wide, nearly twice length of pronotum, scarcely longer than tube; mouth-cone pointed at apex, about 0·6 times length of head; fore wings strap-shaped, widest near base, narrowest near apex; legs long and slender (fig 34) . . . . . **Liothrips** Uzel

X. Accounts of the Species.

The arrangement of species in the following account is based on Morison (1947–49) and the species are listed in the contents at the head of the present paper and in Table I.

A. Terebrantia, Thripidae.

(1) *Heliothrips haemorrhoidalis* (Bouché). (Fig. 1). Greenhouse Thrips.

Body dark brown, apex of abdomen usually orange-coloured. Young adults with a pale brown head and thorax and a yellow abdomen (*abdominalis* Reuter). Antennae, legs, wings pale yellow. *Length* 1·2–1·7 mm.

Priesner (1926–27) described ♀♀ and immature instars ; Crawford (1940) the ♂ ; Reyne (1927) the mouth-parts of var. *angustior* ; Müller (1927) internal anatomy of the larva ; Buffa (1911) and Pussard-Radulesco (1931) parthenogenesis ; Sharga (1933*a*) internal, and Doeksen (1941) external anatomy of the female ; and Bournier (1956) oviposition and oogenesis. Speyer and Parr (1941) described larvae of adults of var. *abdominalis* Reuter ; these, with Pomeyrol (1928) and Bailey (1933), I consider to be young females which, with age, will acquire the darker coloration characteristic of the species.

Practically cosmopolitan in distribution, this species breeds in the open in warm to hot countries between latitude 45° N. and 40° S, *e.g.* S. France, southern States of U.S.A., India, Sumatra, Belgian Congo, S. Africa, Brazil, Chile, Argentina, N. Island of New Zealand, and under glass in colder countries. It has been recorded from under glass in most European countries, northern States of the U.S.A., and in Canada. In Georgia, U.S.A., Watson wrote in 1922 that it entered glasshouses from local wild food plants, and in Georgia, U.S.S.R., Voitenko in 1937 recorded it breeding in numbers in neglected glasshouses and carried from them to gardens and parks. Distributional records have increased steadily since 1833, when Bouché described the species from females in a German glasshouse ; he considered its native land to be America, and Hood (1913) considered it indigenous to tropical and subtropical America. Priesner (1923) recorded var. *angustior* from Liberian coffee and wild plants far from cultivated areas in Surinam. It is so widespread and has larval host-plants in so many different families that its native country may extend even wider than Hood's definition.

Haliday in 1836 described *Heliothrips* gen. n. *adonidum* sp. n. (♀♀) inhabiting flowers in hothouses in Britain and in 1852 he adopted Burmeister's 1838 synonymy of *haemorrhoidalis* Bouché. Ruricola (Curtis, 1841) briefly described female, larva and pupa as *Thrips adonidum* Hal. and the blotching and soiling by it of leaves of tropical plants in hothouses in England ; he advised control by flowers of sulphur. Westwood (1880) refers to Ruricola's paper. Cameron (1886) wrote that the species was common on all plants in hothouses (around Glasgow) and recommended control by killing the insects by gentle pressure of infested leaves between the fingers, particularly for ferns. Bagnall (1909*a*) records it from hothouses in London, Cambridge and Newcastle-on-Tyne and (1909*b*) from Kew Gardens, Surrey ; Miles (1926) on palms and azaleas in hothouses in England ; Speyer in 1926 as injurious to *Aspidium* sp. under glass in England, and in 1940 to cyclamen in Devon ; Miles (1926*a*, *b*, 1928) describes it in English glasshouses, and Miles and Miles (1948) its habits and control. It has been reported frequently from various glasshouses in England

and Wales by entomologists in the National Advisory Services, and some of these reports are condensed in Anon. (1939) (1954). Scottish records are not easily found ; I have taken the insect between 1923 and 1955 in five glasshouses in Aberdeenshire, one in Moray and one in Ross-shire.

The list of species of larval host plants is very long, including *Aleurites*, *Arum*, *Azalea*, *Citrus*, *Chrysanthemum*, *Cocos*, *Croton*, *Cucumis*, *Diospyros*, *Eucalyptus*, *Ferns*, *Gossypium*, *Juglans*, *Nicotiana*, *Persea*, *Pinus*, *Prunus*, *Selaginella*, *Thea*, *Theobroma*, *Viburnum* and *Vitis*.

Adults and larvae cause bleaching of green parts of plants by removal of the contents of the upper cells. Larvae deposit larger faecal globules than adults. The liquid faeces spread on the plant, covering much of the area frequented by the insects and causing unsightly brown patches through becoming infested by brown fungi.

The species is the most widespread and economically important of the introduced thrips in Britain and is often of economic importance abroad in the open or under glass. Bailey (1940) records it as of major importance amongst thrips pests in glasshouses in the U.S.A. He notes (1935) that it has not been investigated in respect of its plant virus carrying capacity. King in 1941 considered it a possible vector of phloem necrosis in tea in Ceylon, and Reiniger in 1942 of zonate chlorosis of *Citrus* in Brazil.

The life history and bionomics have not been studied in detail in Britain. Rivnay (1934, 1935) has described the life-history and bionomics on *Citrus* in Palestine, where there are seven overlapping generations ; he found the life-cycle to take 30–32 days at 26–28° C., 40 days at 23°–25° C. and two months at 20°C. The female lays about 50 eggs. Bailey (1938) writes a complete account of the insect and its habits under Californian conditions. A life cycle of less than 20 days, and over 12 generations in a year, are recorded from a Belgian hothouse. Adults and larvae are rather sluggish and live together on the plant. Pupation is on a plant or in the soil.

Enemies include a Trichogrammatid parasitising the eggs in Hawaii, and a Eulophid parasite introduced to Trinidad, where there is also a predatory Phlaeothripid.

(2) *Hercinothrips bicinctus* (Bagnall). (Fig. 2). Smilax Thrips.

Head, thorax and apex of abdomen yellowish-brown, segments II–VIII dark brown ; antennae yellow with II and VII–VIII yellow shaded brown ; fore wing yellowish with 2 narrow, brown cross bands, apex pale, long bristles on costa, first and second long veins ; legs generally yellow but fore femur lightly shaded brown, middle and hind femora darker brown, fore and hind tibia lightly shaded brown near base, middle tibia darker brown. *Length* 1·2–1·5 mm. ; male smaller.

The ♀ was described by Bagnall (1919) as *Heliothrips bicinctus* sp. n. Van Eecke (1922) described it as *H. femoralis* Reuter. Priesner (1926–28) mentioned the synonymy and described the ♀. The insect was placed in *Hercothrips* Hood before Bagnall instituted it the type species of *Hercinothrips* in 1932. The ♂ and immature instars are undescribed ; the life-history and habits have been briefly described by Veitch (1938) who called it the Banana Silvering Thrips in Queensland.

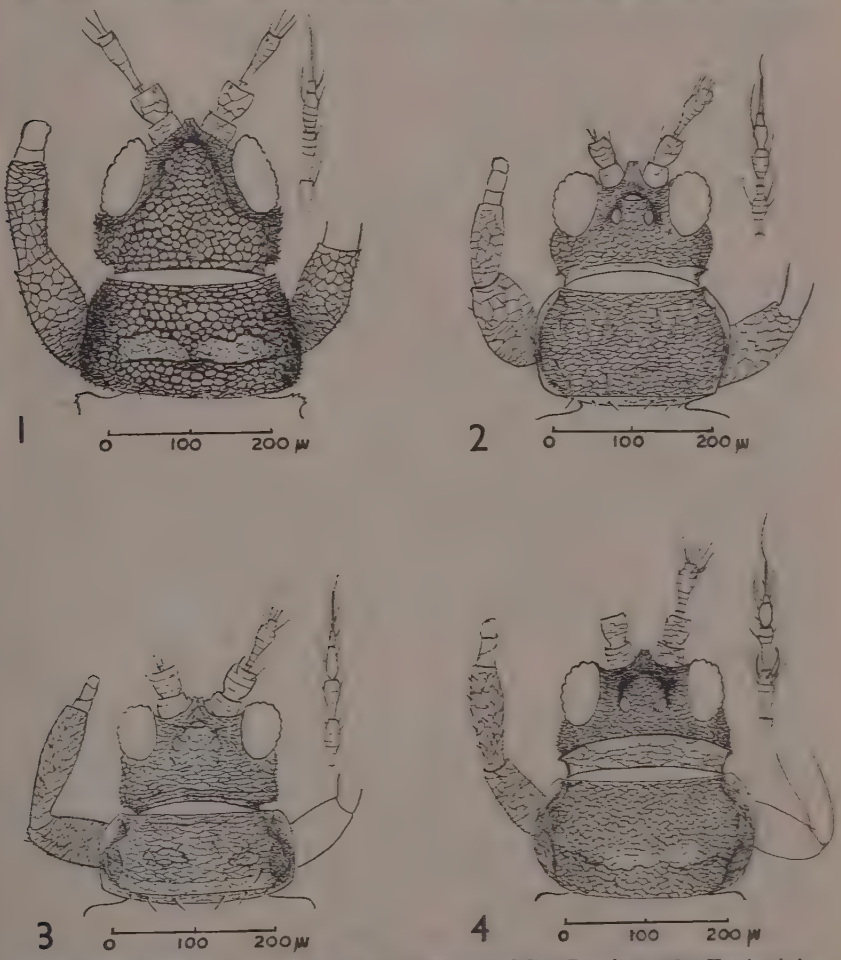
It is recorded in the open from Spain, S. France, Zululand, S. Africa, Queensland and New Zealand, is probably native to certain warm temperate

or subtropical regions, and a glasshouse species in England (Bagnall, 1919: Miles, 1926*a*; Morison, 1948), Germany (Titschack, 1942) and the colder countries of Europe.

It is found on Smilax, asparagus, banana, tomato and other plants. Miles (1926*a*) describes its control on Smilax (*Asparagus meledoides*) in glasshouses in England.

(3) *Hercinothrips femoralis* (Reuter). (Fig. 3). Banded Greenhouse Thrips or Sugar Beet Thrips.

Head, prothorax, abdominal segments VIII–X yellow, shaded brown; pterothorax, abdomen I–VII brown; antennae yellow with VI–VIII brown and apex of IV, V shaded



FIGS. 1–4.—Females of: (1) *Heliothrips haemorrhoidalis* (Bouché). (2) *Hercinothrips bicinctus* (Bagnall). (3) *H. femoralis* (Reuter). (4) *Helionothrips errans* (Williams).

lightly brown: fore wing brown, a clear area near the base, another before the distal quarter and a third at the extreme apex; these very short and indistinctly defined; all tibiae, tarsi and fore femora yellow; mid and hind femora brown. *Length* 1·2–1·5 mm.

Reuter described macropterous ♀♀ (as *Heliothrips femoralis*); White (1916) ♀, ♂ and immature instars; Priesner (1926–28) ♂ and ♀; Petersen (1915) described and figured mouth parts of the ♀; Speyer and Parr (1941) the external structure of II.

It is recorded from glasshouses in most European countries, many States in the U.S.A., Canada and Argentina and in the open or under glass in Bermuda, Oahu, Kauai, E. Africa, southern States of U.S.A. and Puerto Rico: I have named the species for the Commonwealth Institute of Entomology from New Zealand. Hood (1914) suggested that it is of neotropical origin.

Bagnall (1908) recorded one specimen from London and specimens on orchid leaves at Wylan-on-Tyne, Northumberland, (1909*a*) specimens at Kew and Newcastle-on-Tyne on a large variety of plants, (1909*b*) on five species of plants at Kew Gardens, Surrey, and (1919) on various plants at Newcastle-on-Tyne. I found 35 ♀♀, 2 II, and 1 ♀ pupa on *Tradescantia* in a glasshouse in Aberdeen, 8.xii.1927. In England Miles (1927) described control on orchids; Speyer (1933) control on *Cineraria* and other hothouse plants; Miles and Miles (1948—brief description) the female, habits and control; and Staplehurst (1946) control. Swezey (1945) intercepted it at Honolulu and New Jersey on *Cypripedium* from England.

Eide (1943) listed 51 species of plants infested in a greenhouse in Washington over several years with notes on degrees of infestation: Amaryllidaceae were apparently preferred, though *Narcissus* sp. and *Zephyranthes candida* were not particularly favoured. Plants infested were *Arum*, *Aster*, *Begonia*, *Beta*, *Chrysanthemum*, *Cineraria*, *Cucumis*, *Crassula*, *Dracaena*, *Emilia*, *Ficus*, *Gossypium*, *Gardenia*, *Gladiolus*, *Gerbera*, *Ipomaea*, *Lycopersicum*, *Musa*, *Phaseolus*, *Solanum*, *Saccharum*, *Sempervivium*, *Sonchus*, *Vitis* and *Xiziphus*.

Life-history and bionomics have been studied in the U.S.A. but not in detail in Britain. Adults and larvae are rather sluggish and live together in colonies on plants. Adults can jump, and White (1916) twice observed flight in Washington, D.C. Males are scarcer than females. Parthenogenesis has been discussed by White (1916), Bailey (1933) and Eide (1943). Pupation occurs on plants or in shelter on soil. Injury is marked by silvering, blotching and drops of excrement. The species transmits a bacterial disease of beans in Minnesota, according to Buchanan in 1932, but did not transmit the virus of Spotted Wilt (Sakimura, 1953) in Hawaii.

White (1916) dealt with the history, distribution, food plants, injury, habits, life cycle and control. Bailey (1938) gave a general account of the species: the average length of the egg stage is 13 days and about an equal period is required for the larva to develop. The pupal stage lasts about six days. Judging from the limited data available on the species, the total life cycle averages 30–38 days in glasshouses in California. He describes methods of control.

(4) *Helionothrips errans* (Williams). (Fig. 4).

Body yellowish-brown; antennae yellow, II and VI brown; fore legs yellow lightly shaded brown, middle and hind legs brown with apex and base of femur and tibia paler.

yellowish; wings pale brown with clear area near base and another, more indistinct, near apex. *Length* 1·2–1·4 mm.; male smaller.

Williams (1916) described the species from 3 ♀♀ on orchids, *Laelia anceps*, from a glasshouse in Surbiton, Surrey, England. Swezey (1945) recorded interception of the species at Washington, D.C., on orchids from England. Priesner (1926–28) redescribed the ♀ and (1935) described the ♂ from a single specimen found out of doors in Formosa. I have named numerous ♀♀ and 1 ♂ in 1944 from coffee in Kenya for the Commonwealth Institute of Entomology. Hood recorded it from out of doors in S. Africa. Immature instars are undescribed, and the life-history and bionomics unknown. No damage of economic importance is reported. The native country is unknown, perhaps Venezuela or other parts of S. America, with certain species of orchids as larval hosts.

(5) *Caliothrips* (*Hercothrips*) *fasciatus* (Pergande). (Fig. 5). Bean Thrips.

Body dark brown; antennal segments I, II, VI–VIII brown, III–IV yellowish with darker median band, apex of V brown; legs dark brown, fore and middle femora yellowish at apex, hind femora brown; all tibiae yellowish at base and apex, tarsi yellow; fore wing brown with hyaline cross band near base and another before apex.

Both sexes and immature instars are described by Bailey (1937, 1938) with a list of plants frequented and control in California. It is recorded from U.S.A., Mexico and Brazil and is probably native to the neotropical regions. Its carriage by commerce is shown by the statement of Kurosowa that it was not established in Japan (in 1938) but was common on oranges from the U.S.A. and even from Canada. It can survive the winter in Yokohama. Whitney, in 1930, recorded its interception at Hawaii on tangerines and oranges from California and that it was not recorded from Hawaii. Sakimura and Krauss, in 1944, state that it was not found previously in the Hawaiian Islands but was numerous in June 1943 in Molokai, probably introduced from California on plant material, and that the original infestation apparently died out during the hot dry summer.

Infested plants include alfalfa, *Argemone*, apple, beans, beet, *Cassia*, *Citrus*, cotton, figs, lettuce, melon, peach, peas, pear, pine, poplar, radish, *Sonchus* and vetch.

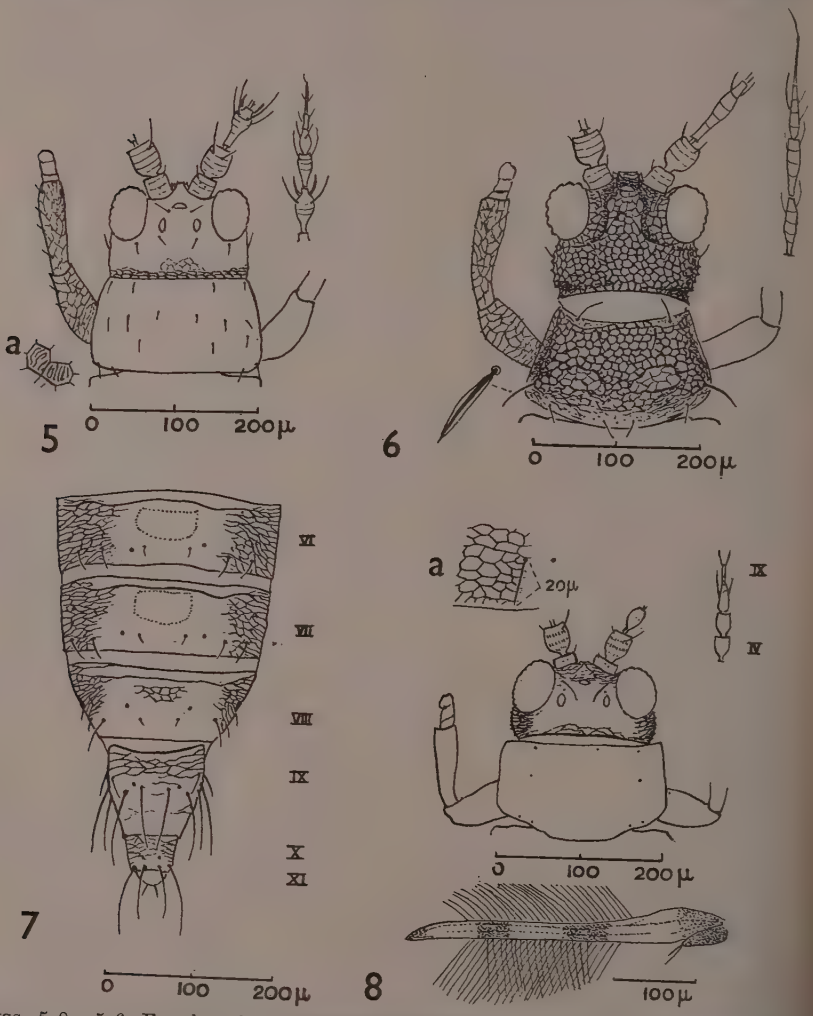
(6) *Parthenothrips dracaenae* (Heeger). (Figs. 6, 7). Palm or Dracaena Thrips.

Body yellowish-brown; antennae yellow with VI–VIII brown; tibiae and tarsi yellow; femora brown, shaded yellow at base and apex; wings hyaline with brown reticulations on membrane near dark brown bases of long veins and near apical third, where veins shaded brown. *Length* 1·2–1·3 mm.; males similar, smaller.

Heeger (1854) described ♀, ♂, egg and some immature instars (as *Heliothrips dracaenae* sp. n.); Jordan (1888) anatomy of adults and the occurrence of ♂♂ in cold houses; Uzel (1895) erected *Parthenothrips* for *dracaenae* Heeger and described ♀, ♂; Hinds (1902) and Van Eecke (1922) described ♀, ♂, egg, II and prepupa; Priesner (1926–28) described all stages and synonymy; Borden (1915) mouthparts and feeding habits; Doeksen (1941) ♀ external

structure; Speyer and Parr (1941) II; Müller (1927) internal anatomy of immature stages; Pussard-Radulesco (1931) the evolution of the nucleolar-chromosome complex.

Probably subtropical in origin, it seems to thrive best in the cooler glasshouses and has been recorded from most countries in Europe, Siberia, S. Africa, many states of U.S.A., Canada, Australia, Hawaii and New Zealand. Bagnall (1908, 1909*a* and *b*, 1911) recorded it from Acton, London; Newcastle-on-



FIGS. 5–8.—5–6, Females of: (5) *Caliothrips fasciatus* (Pergande); (*a*) reticulation on head. (6) *Parthenothrips dracaenae* (Heeger). (7) Male dorsal view of terminal abdominal segments of *P. dracaenae* (Heeger). (8) Female of *Dendrothrips ornatus* (Jablonowski); (*a*) reticulation on abdominal tergite IV.

Tyne ; Kew Gardens, Surrey, England. Miles (1926*a* and *b*), Miles and Miles (1948), and Staplehurst (1946) recorded it from England without specific localities. Swezey (1945) recorded interception at Honolulu and Washington, D.C., on plants from England. It seems not to have been named in reports of the National Agricultural Advisory Service in England for many years. Between 1924 and 1956 I found it in six glasshouses in Aberdeenshire, one each in Kincardineshire and Morayshire (females throughout the year, males from April to September in two cold houses, immature instars from April to September).

Larval hosts are generally Liliaceae, including *Anthurium*, *Aspidistra*, *Calla*, *Dracaena*, *Kentia*, *Lapageria*, *Musa* and *Tradescantia*. Adults have been recorded on many other plants, including *Croton*, *Cycas*, *Crinum*, *Citrus*, *Ficus*. Considerable bleaching of green parts may occur on an attacked plant.

The life-history and bionomics have not been studied in detail under rigidly controlled conditions. General accounts of the life-history have been published by Heeger (1854) in Vienna, Ahlberg (1922) in Sweden.

Müller (1927) discusses heliotropism and moulting and the occurrence of males in Germany ; Pussard-Radulesco (1930) says that in a Paris hothouse two races, one parthenogenetic and the other sexual, developed simultaneously and under the same conditions, and (1931) discusses the relation between parthenogenetic generations and the temperature.

Its economic importance and control in Sweden is discussed by Ahlberg (1922) ; and by Miles (1926, 1926*b*), Miles and Miles (1948) and Staplehurst (1946) in England ; Bailey (1938) says that it is rarely injurious or only very infrequently reported as such in the U.S.A.

I have found adults and larvae attacked by fungus in Aberdeen. Sakimura in 1953 reported it was not a vector of Spotted Wilt Virus on *Emilia* in Hawaii.

(7) *Dendrothrips ornatus* (Jablonowski). (Fig. 8). Privet Thrips.

Body yellowish-brown ; antennae short, yellowish-brown with II, VII-IX and apex of VI darker ; legs greyish-brown, tarsi yellowish ; fore wing hyaline with brown cross bands, one at base, one on either side of middle and a small one at tip. *Length* 0·9–1·1 mm.

Priesner (1926–28) described ♀, ♂, I, II.

Recorded from many European countries, it is probably best adapted to the warmer ones, and has apparently been introduced to various States of the U.S.A. Bagnall recorded a " specimen " from Perthshire and he found females (*schillei*) on *Ligustrum* in Hampshire. Fowler (1954) recorded infestations of several acres of young *Ligustrum ovalifolium* and *Syringa* in Surrey. I found females on *L. vulgare* in Middlesex.

Larval hosts include *Tilia*, *Ligustrum*, *Syringa* and *Alnus*. Moulton recorded considerable damage to *Ligustrum ovalifolium* in New Jersey, but Bailey (1940) reported the insect of minor importance in the U.S.A.

Its life-history and bionomics are undescribed but are being studied by Fowler in Surrey.

(8) *Asprothrips raui* J. C. Crawford.

Body very light yellowish-white, including basal antennal segments, IV light brown, V–VIII dark brown, with V lighter at base. *Length* 1·1 mm.

Crawford (1938) described ♀ and 1 ♂ from glasshouses in New York Botanical Gardens on Palm, *Anthurium*, *Carludovica atrovirens*, *Baetis utilis*, *Alocaria odora* and *Aglaonema modestum*, some rather severely injured. Its native country is unknown.

(9) *Scirtothrips longipennis* (Bagnall). (Fig. 9). Long Winged Thrips.

Body and legs pale yellow; antennal segment I almost hyaline, II yellowish-grey, III–VIII grey; fore wings brownish-grey. *Length* 0·9 mm.

Priesner (1926–28) described ♀ and II; (1932) ♀, synonymy; Speyer and Parr (1941) II.

It is recorded under glass in Newcastle-on-Tyne, England, by Bagnall (1909, 1909*a*), and by Speyer (1935) in Surrey; Swezey (1945) intercepted it on *Cypripedium* at Honolulu from England. I found one female on *Gloriosa* in the Chelsea Physic Gardens, London, in 1923 and another in the same glasshouse in 1947 and I received females from the late J. R. W. Jenkins from a glasshouse at Aberystwyth, Wales. It has also been recorded under glass in Belgium, Holland, Denmark, Germany, Finland, Sweden, California, Illinois, British Columbia and in the open at Puerto Rico. Its native country is unknown but is probably subtropical or tropical.

Host plants include *Adianthum*, *Amaranthus*, *Anthurium*, *Begonia*, *Caladium*, *Cathartica*, *Cinchona*, *Cyclamen*, *Diffenbachia*, *Ipomaea*, *Pharbitis* and *Philodendron*. Injury may be severe (Speyer, 1935; Andison, 1938, Vancouver Island; Thomsen, 1923, Denmark; Ahlberg, 1924, Sweden). Control is discussed by these authors. Bailey (1938, 1940) considered it of minor importance in California and other States of U.S.A.

The life-history and bionomics have not been studied in detail. The male is undescribed. Thomsen (1923), calling it *Euthrips parvus* Moulton, found females in glasshouses in Denmark on plants exposed at 41–46° F. or even lower. Andison found the species particularly active on bright days at temperatures above 75° F. in Vancouver Island.

(10) *Leucothrips nigripennis* (Reuter). Fern Thrips.

Body pale yellow; fore wings dark grey. *Length* 0·9–1·1 mm.

Priesner (1926–28) described ♀ and II, quoting Reuter's descriptions, which are too brief to be satisfactory by modern standards. Herrick in 1927 described the ♀ as *Microthrips leucus* sp. n. from Michigan. It is a delicate insect of which the lack of good specimens has complicated the classification.

It is probably tropical or subtropical in origin, and only recorded from glasshouses in Finland, Belgium and Britain (Newcastle-on-Tyne and Glasgow, Bagnall (1909*a*, *b*, 1911)) and from Michigan.

It occurs on *Adianthum*, *Davallia* and *Pteris*, and was reported in 1926 as having caused considerable damage to ferns in glasshouses in Michigan. Its life-history and bionomics are undescribed.

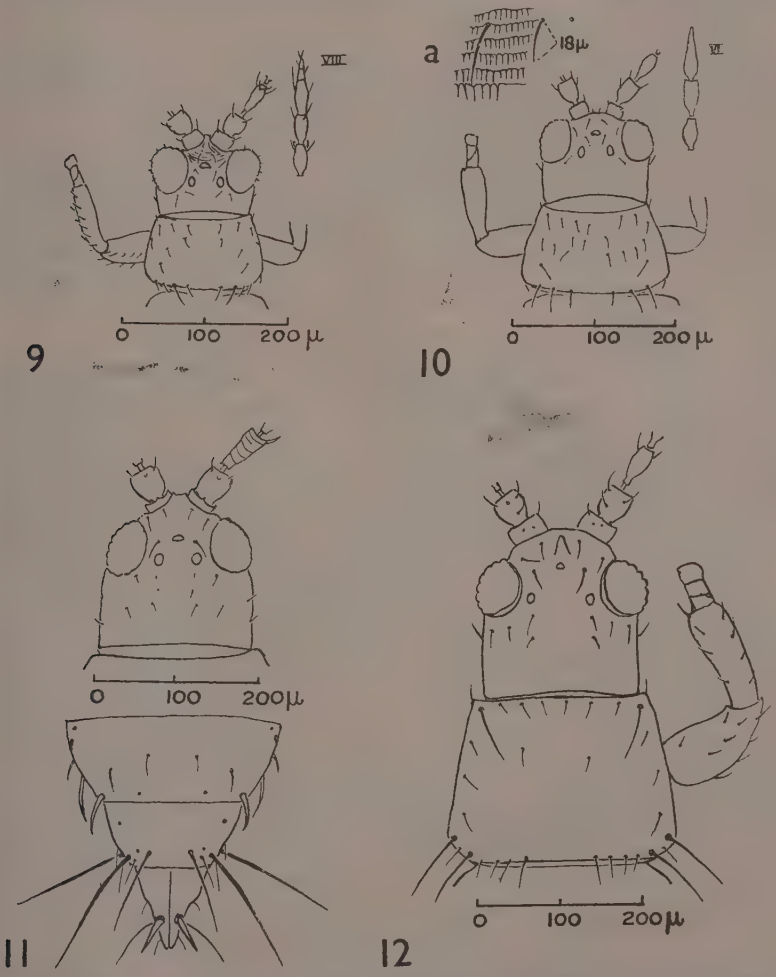
(11) *Drepanothrips reuteri* Uzel. (Fig. 10). Grape or Vine Thrips.

Body yellow, shaded with brown; legs concolorous with body; wings greyish-brown; antennae dark grey-brown with III paler and I hyaline. Male bears pair of long, dark ribbon-like hairs on sides of abdominal segment IX. *Length* 0·9–1·2 mm.; male smaller.

Priesner (1926–28) described ♀, ♂, II, prepupa and pupa.

Probably best adapted to south and south-east Europe, it is recorded from many European countries, England, Scotland and Caucasia; also Algeria (new record) and (as an introduction) California.

Larval hosts in the open include *Quercus*, *Vitis*, *Corylus* and *Betula*. It is a rather serious pest of vines in Italy, S. Russia and California. Its economic significance, bionomics and control in California have been discussed by Moulton (1926, 1928, 1931) and Bailey (1938, 1940, 1942), who writes that it has five to six overlapping generations, and he believes that adults overwinter. In Italy



FIGS. 9–12. Females of: (9) *Scirtothrips longipennis* (Bagnall). (10) *Drepanothrips reuteri* Uzel; (*a*) microtrichia on abdominal tergite IV. (11) *Limothrips cerealium* Haliday. (12) *Iridothrips iridis* (Watson).

there are at least two generations on vines, and females overwinter. In N.E. Scotland the larval hosts are *Quercus robur*, *Q. petraea*, and there seems to be one generation, the females overwintering.

(12) *Limothrips cerealium* Haliday. (Fig. 11). Corn Thrips.

Dark brown; antennae brown, III only slightly paler than the other segments, II symmetrical in dorsal outline, III produced slightly outwards near apex, III, IV each with simple sense cone; legs brown, tarsi yellowish; wings brown; one pair of extra stout bristles on each of abdominal segments VIII and X of female. *Length* 1·3–2·0 mm.; male smaller, apterous.

Priesner (1926–28) described ♀, ♂ immature instars; Speyer and Parr (1941) II; Hinds (1902) ♀, ♂ (as *L. avenae* sp. n.); Haliday (1852) external and internal anatomy; Jordon (1888) internal anatomy; Petersen (1915) ♀ head and mouth parts; Sharga (1933*a*) internal anatomy of the larva.

Probably best adapted to the western countries of Europe, it is recorded from most European countries, India, Palestine, Egypt, S. Africa, many States of U.S.A., S. America, Australia, Hawaii and the Seychelles. Abundant in parts of the British Isles, it ranges from sea level to an altitude of at least 1200 feet. Apparently most numerous in the east of Britain, it is commoner towards the south than the north of its eastern range and does not extend into Caithness, N.W. Scotland, Skye, Outer Hebrides, Orkney or the Shetland Islands.

Females migrate by flight in spring from tree trunks, dead wood, debris and other habitats, where they hibernated to the Gramineae on which they breed, and also sometimes in vast numbers, in late summer and early autumn from cereals and grass to winter quarters. I have found the species on 226 different species of plants of which 47 were Gramineae, and on many inanimate objects. Hardy and Milne (1938) caught four females at a height of over 250 feet in the air in Lincolnshire. Autumn migrants frequently enter buildings, including supposedly insect-proof structures. This is probably the species recorded by Müller in 1872 as soiling framed engravings in an hotel in Surrey. I have found 12 females on different species of plants in glasshouses of Aberdeenshire and Moray during May to November of the last few years, and undoubtedly the species could be found if sought in glasshouses in many other parts of the British Isles. It seems unlikely to harm glasshouse plants, but probably would breed on maize or other Gramineae in a glasshouse.

In Britain there are apparently one to three generations in the year (Morison, 1928, 1943), depending on locality and climate. Pupation occurs on plants. It may cause blindness in cereal grains as well as bleaching of the green parts, according to Sharga (1933) who writes on the bionomics in E. Scotland. Bailey (1948) dealt with its importance to Gramineae. An early description of the insect and its damage to cereals in England is that of Curtis (1845) who quotes Kirby's earlier accounts of damage. The attraction to chemicals noted by Morgan and Crumb (1928) in Tennessee has been mentioned above. Peklo, in 1946, discussed symbiosis of *Limothrips* sp. with Azotobacter.

(13) *Limothrips denticornis* Haliday. Grain or Corn Thrips.

Body dark brown; antennae brown, III very slightly paler than the other segments and drawn into a prominent, acute triangular process on the outer angle, less marked in

male ; III with simple, IV with forked sense-cone ; VI about one quarter longer than IV in females, about equal in length in males ; postero-angular bristle of pronotum of female 55–78 μ long ; bristle at side of abdominal segment IX of male varies from stout to slender, 34–78 μ long, inserted into a papilla 6-8 μ long ; legs brown, fore tibiae and all tarsi paler ; wings yellowish-brown. *Length* 1·5–2·3 mm. ; males smaller, apterous.

Priesner (1926–28) described ♀, ♂, immature instars ; Pussard-Radulesco (1931) habits, fertilisation of the female pupa by the male, parthenogenesis ; Bournier (1956) confirmed Pussard-Radulesco's observations and described oogenesis and spermatogenesis.

Probably best adapted to east Europe, it is recorded from most European countries, Siberia, Ithaca and New York. In the British Isles distribution and habits are like those of *L. cerealium*, but the species does not seem to extend so far north or north-west and is probably scarcer than *cerealium* except in the barley-growing districts of England. I have found it on 66 species of plants of which 30 were Gramineae. It breeds on some of the larger species of grass, and cereals, particularly barley. Migrating females may leave the cereals in huge numbers and some are likely to enter glasshouses. Heeger in 1852 described the female as *Thrips kollari* sp. n. and recorded it as breeding on *Ficus* and *Begonia* in a hothouse in Vienna, but the larvae were almost certainly those of another genus.

(14) *Iridothrips iridis* (Watson). (Fig. 12). Iris Thrips.

Females macro-, hemimacro- or micropterous, males micropterous, ? apterous. Body dark brown ; antennae brown, III yellow, IV, V yellowish-brown ; tibia I, apices of other tibiae and all tarsi yellow ; wings pale yellow. *Length* 1·5–1·7 mm. ; males smaller.

Watson described the species in 1924 under *Bregmatothrips* from females intercepted at New York on *Iris kaempferi* from Holland and on *Iris* from England ; Smith (1933) said that it was frequently intercepted in U.S.A. on *Iris* from Holland, England and France. Priesner (1926–28) described ♀ ; Maltbaek (1929) ♀, ♂, II, prepupa and pupa.

It has been recorded from the open from France, Holland, Denmark, Germany, England and S. Scotland and seems to have been introduced to various States of the U.S.A. It seems likely to be native to some western European countries.

Larval hosts in the open include *Iris pseudacorus*, *laevigata* (*kaempferi*), and the *germanica* complex.

Smith and Utter (1937) described its bionomics and control on *Iris* in New York. Bailey (1940) mapped its distribution in U.S.A. and considered it of minor economic importance. Development from egg to adult occurs on the lower parts of the leaves and the plants may be growing in water. Flowers are rarely attacked.

(15) *Aptinothrips rufus* (Gmelin). (Fig. 13). Grass Thrips.

Haliday in 1836 erected the subgenus *Aptinothrips* for a species with 6-segmented antennae, which he considered was *Thrips rufa*, named by Gmelin in 1788 for " der rothe Blasenfuss " of Gleichen, who, in 1764, stated that a *Thrips* occurred in *Triticum* and illustrated it with two figures, one of a larva

coloured bright red. The spelling *Aptinothrips*, instead of the accurate transliteration from the Greek of *Aptenothrips*, is accepted for the genus, of which the type species *rufus* (Gmelin) Haliday was designated by Westwood in 1838. Speyer (1935) missed Westwood's designation when revising the genus, but fortunately he chose the same type species. The genus and species should persist in science, although I consider that Gleichen's illustration represents the crimson larva of *Haplothrips* sp. (? *aculeatus* Fabr.) and not the yellowish larva of *Aptinothrips* or, as Speyer suggested, the larva of *Limothrips cerealium*, which may be orange coloured. The red larvae of species of *Haplothrips* are common to abundant on cereals and grass in the Germanic parts of the European continent where Gleichen and Gmelin lived, but there is no record of them in cereals and they are rare in grass in the British Isles where Haliday gained his experience of thrips.

Body yellow or brownish-yellow; antennae coloured like body except VI, which is darker brown. *Length* 1·1–1·5 mm.; male smaller and scarcer.

Uzel (1895) described the ♀ as *A. rufus connaticornis* and Priesner (1926–28) and Speyer (1935) all stages as *rufus*; Pussard-Radulesco (1931) discussed races, sexuality, parthenogenesis and the number of generations in France; Sharga (1933) the biology and life-history in E. Scotland, and (1933*a*) internal anatomy of the larva; Speyer and Parr (1941) described I, II; Morison (1943) bionomics, and larval host plants in N.E. Scotland; and Bailey (1948) economic importance to Gramineae.

Probably native to the holarctic region excepting the colder portions, it is recorded from practically all European countries, many States of the U.S.A., and is also found in Egypt, India, Chile, New Zealand and apparently Victoria, Australia. The commonest thrips in the British Isles, distributed extensively throughout, ranging from grass which is submerged twice daily by normal high tide to grass at least 2600 feet above sea level. Apparently not previously recorded from a glasshouse, though it could be introduced easily with soil or plants, I found two ♀♀ (xi.1943) and five ♀♀, I, II (ix.1944) on *Poa annua*, breeding in the same glasshouse as *Heliothrips haemorrhoidalis* at Brodie, Morayshire. It breeds on many species of Gramineae and I have found it in the British Isles on 54 species of this group and (females only) on 36 species of plants of other families.

(16) *Aptinothrips stylifer* Trybom.

A. stylifer Trybom was described by Uzel (1895) as *A. rufus* (Gmelin) and till 1926–28, when Priesner monographed the European Thysanoptera, many authors adopted this, thereby complicating the naming. It is arctic-alpine in distribution, as mentioned by Priesner, and much more numerous in the north than the south of Britain, but even in the north it is scarcer than *rufus*, except where its particular larval hosts, *Deschampsia caespitosa* and *D. flexuosa*, have been growing for some years.

(17) *Anaphothrips obscurus* (Müller). (Fig. 14). Thrips.

Body yellow, more or less shaded with brown; antennae greyish-brown, I hyaline or yellow, III, IV yellowish at base; wings pale brownish-yellow, but reduced to small scales in micropterae. *Length* 1·1–1·5 mm.

Hinds described ♀, immature stages and habits (1900, 1902) (as *A. striata* Osborn) ; Priesner (1926–28) ♀ immature stages ; Speyer and Parr (1941) I and II ; and Petersen (1915) ♀ head and mouth-parts. Shumsher in 1942 mistakenly erected *Pseudoarticulella* gen. n. for *A. obscurus* Müller.

Males are perhaps unknown, for Cory was mistaken in his determination of the male from Maine in 1902, and Hinds never described the males which he told Hewitt he had found, after writing his monograph in 1902 ; Shull's (1909) description is inadequate to define the species of the two males from Michigan.

Recorded from most European countries, Siberia, many States of U.S.A., Canada and also from Egypt, Australia and Hawaii, it is perhaps native to the holarctic region. It is widely distributed in Great Britain—Devon, Kent, Norfolk, Glamorgan, Caithness, Lewis and many intermediate counties.

In Britain females occur throughout the year, macropterae migrate by flight during July, and macropterae and micropterae hibernate amongst grass. Immature instars occur on Gramineae from May to November and there are apparently two generations in the year in N.E. Scotland. I have found the insect on 73 species of plants including 33 Gramineae, out of which it bred on at least 17 species. The thrips thrives on soft-leaved grasses growing in persistently damp or wet soil, but it can multiply on grass and cereals in well drained soil in Europe and U.S.A., and may cause damage of economic importance (*cf.* Morison, 1943 ; Bailey, 1940, 1948).

I found one female macropterous on *Tradescantia* in a glasshouse in Ayr. Bianchi (1945) recorded the species from an open greenhouse in Hawaii.

(18) *Anaphothrips*. (19) *Neophysopus*.

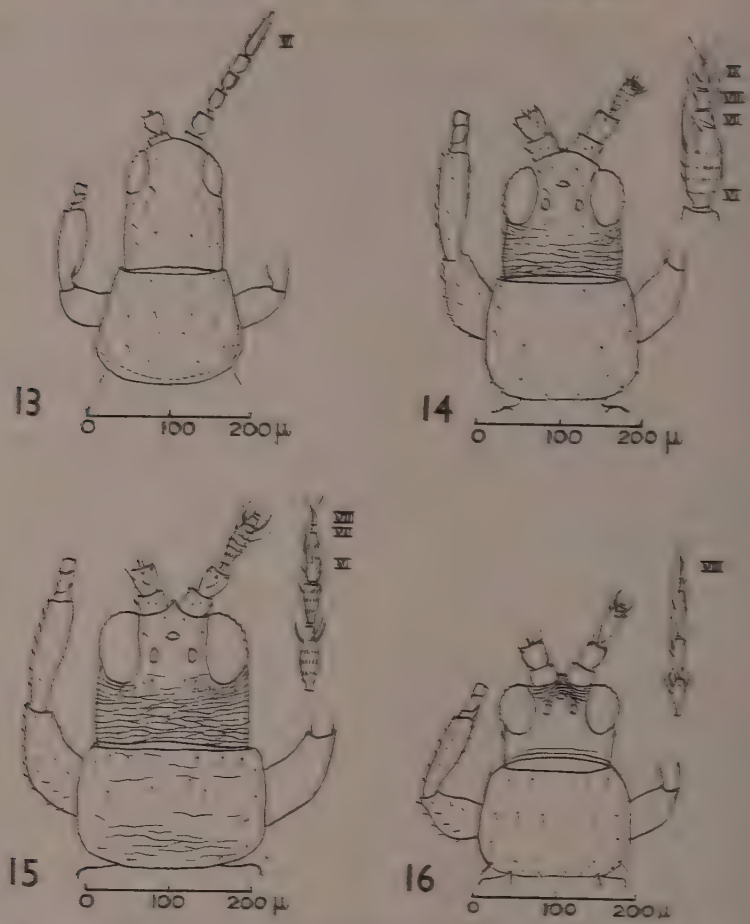
Various species of these genera have been recorded from orchids in tropical countries and there is thus the chance of their introduction to Britain ; they are closely allied to *Chaetanaphothrips* and *Dichromothrips*.

(20) *Neophysopus orchidaceus* (Bagnall). (Fig. 15). Yellow Orchid Thrips, Yellow Thrips.

Body yellow, with two long, dark brown stripes that start behind the eyes, are united on the thorax and occur as a dark patch on each of abdominal segments II–VII ; antennae brown with the base and apex of III and base of IV, V paler ; legs yellow ; fore wing pale greyish-brown with hyaline area near base and an indefinite darker cross band near base of second vein. *Length* 1·1–1·4 mm. ; male smaller.

Priesner (1926–28) described both sexes (as *Anaphothrips orchidaceus*) and Sakimura (1955) some anatomical characters. It is recorded from glasshouses in England, Scotland, Ireland, Belgium, Denmark, Norway, Sweden and France and is probably native to North, Central and South America (Sakimura). Bagnall (1909, 1909*a*, *b*, *c* ; 1910, 1913, 1926) recorded it from orchids in glasshouses in Northumberland, Kew Gardens, Dublin, Edinburgh and Glasgow. Williams (1913) described a male from orchids in Liverpool Botanic Gardens, and I saw a male from Stockport, Lancs., in the collection of the late H. Britten. Swezey (1945) records interception on orchids from England at Washington, D.C., and at Honolulu and California.

It has been found on *Chaemodora*, *Cymbidium*, *Cypripedium*, *Epidendron*, *Miltonia*, *Mormodes*, *Odontoglossum*, *Oncidium* and *Zygopetalum*. Damage



Figs. 13–16.—Females of: 13 *Aptinothrips rufus* Gmelin. 14 *Anaphothrips obscurus* Müller. 15 *Neophysopus orchidaceus* Bagnall. 16 *Chaetanaphothrips orchidii* Moulton.

to plants is not described, but Bagnall told me that the green tuberous parts of infested orchids were usually marked with brown patches. Its life-history and bionomics are unknown.

(21) *Dichromothrips* Priesner.

The type species of *Dichromothrips* is *orchidis*, which Priesner described in 1932 from a female and male introduced to a glasshouse in Burma with the orchid, *Dendrobium thyrsiflorum*. Sakimura (1955) revised the genus, in which he included seven species infesting various species of orchidaceous plants and apparently Malayan in origin, but some are now spread by commerce in orchids

at least to the Hawaiian Islands. The genus has affinities with *Anaphothrips*, *Neophysopus*, *Chaetanaphothrips* and *Taeniothrips*.

(22) *Chaetanaphothrips orchidii* Moulton. Fig. 14.
Orchid Thrips or Banana Rust Thrips.

Body and legs yellow; antennae yellow with apices of IV, V, apical half of VI and whole of VII–VIII brown; wings grey-brown with a pale cross band just beyond the base and another beyond the apex.

Priesner (1928–29) described ♀, Pelikan (1954) ♀ and ♂ in Czech with illustrations. Bagnall (1914a) described a ♀ from Ceylon as *Taeniothrips* sp. nov. gen. sp. n. and this synonymy was first recognised by Hood in 1954. Girault in 1925, Veitch in 1926 and previously, and Froggatt in 1927 called the insect the Banana Rust Thrips, placing it as *Taeniothrips* or *Anaphothrips*, when describing its attacks on banana plants in Queensland. The ♀ described by Kelly and Morse in 1914 may not be this species. Pelikan (1954) was aware of this synonymy. He considered the species native to Guiana and perhaps the remainder of the Amazon and mapped its world distribution. The insect is recorded in the open in Florida, Hawaii, Oahu, Queensland and Ceylon, and under glass in many European countries, various States of the U.S.A., Cuba, Surinam, Japan and Hawaii. Sakimura and Krauss say that it was introduced to Hawaii where it is now naturalised in the open. Bagnall (1909, 1909a, b, 1911, 1926) recorded females from Newcastle-on-Tyne. I found 21 females, 5 ♂♂ in a glasshouse in Aberdeen (xi 48). Sweney (1945) recorded its interception at Washington, D.C., on *Odontioda* from England.

Larval host plants include *Begonia*, *Bouvardia*, *Epiphyllum*, *Hemerocallis*, *Hypoxis*, *Musa* and *Tradescantia*. Adults are recorded from these and many other species of plants, including orchids. Damage is shown by bleaching of attacked parts of plants, apparently followed by a reddish-brown appearance and marks on the skin of banana fruit. Girault (1925) and Veitch (1926) deal with the life-history and control on bananas in Queensland. Thomson (1939) described injury to *Citrus* fruit in Florida. Bailey (1940) says that it is rarely injurious, or very infrequently reported as such in the U.S.A. Pelikan (1954) dealt briefly with the life-history and bionomics. It feeds under most surroundings, reproduces parthenogenetically, and its life cycle is less than 30 days on *Emilia sonchifolia*, to which it does not transmit the virus of Spotted Wilt, according to Sakimura in 1946.

(23) *Chaetanaphothrips* sp.

Speyer and Parr (1941) described larva I, II, as *Cymbidium* in a glasshouse in Herefordshire, December, 1938. The adult female is quite distinct from *orchidii* Moulton.

(24) *Taeniothrips simulans* (Williams). Fig. 17.

The species is more closely related to *Chaetanaphothrips* and *Dichromothrips* than to *Taeniothrips*, as stated by Sakimura (1955).

Williams described it from Trinidad and it is probably native to tropical S. America. It is recorded from Brazil, Manoa, Honolulu, Florida, Japan

and Australia, and Sakimura says he has seen specimens from England. It attacks orchids (*Cattleya*, *Cypripedium*, *Laelia*) and other plants (*Asystasia*), causing brown patches on leaves ; the plant may die back if infestation is not controlled (De Figueiredo, 1942).

Cory (1941) dealt with its life-history in orchid houses in eastern U.S.A. He found 76° F. apparently the most favourable temperature. Swezey (1945) records it breeding in orchid houses in Honolulu. De Figueiredo describes control by lime sulphur spray in Brazil.

(25) *Taeniothrips picipes* (Zetterstedt). (Fig. 18).

Body dark brown ; antennae dark brown with III yellowish-brown, apex of II and base of IV paler brown ; legs brown, with all tarsi yellowish-brown ; tibiae paler than femora and paler still at base and apex ; wings brown with hyaline base, a dark cross band within the first half and another dark band at apex.

The types species of *Taeniothrips* is *picipes* (= *primulae* Hal.). Priesner (1926–28) described ♀, ♂, I and II ; Speyer and Parr (1941) I and II. Young *adusta* adults of both sexes have the terminal abdominal segments darker than the basal segments, but as the insect ages the abdomen becomes more or less uniformly dark and the whole body may be very dark in August and September.

It is recorded from most European countries and Siberia, and is probably best adapted to north and west Europe. It is locally numerous and widely distributed in Britain : *e.g.* Devon, Sussex, Caernarvon, Sutherland, Caithness and many intermediate counties ; also the Isle of Man, Co. Down and Skye.

Adults occur on many different species of flowering plants in the open. I have found them on 84 species in Britain, where the larval hosts include *Armeria*, *Cochlearia*, *Cymbalaria*, *Digitalis*, *Geranium*, *Hypericum*, *Lotus*, *Melandrium*, *Primula*, *Stellaria*, *Teucrium* and *Vicia*. Larvae and adults may injure *Cymbalaria* and *Digitalis* very severely.

Females occur from March to September, males from March to August, larvae from May to October ; pupation is in the soil, hibernation probably as larva. There are apparently two generations in the year in N.E. Scotland. Adults jump actively and are often covered with pollen when in flowers. Williams (1916) described oviposition in ribs on the underside of leaves of potted primrose plants and made observations on its bionomics. Bagnall in 1913 found the Chalcid parasite, *Thripoctenus russelli* Crawford, with this species on *Linaria* in Devon and I have bred the parasite from full-grown larvae in Kincardineshire.

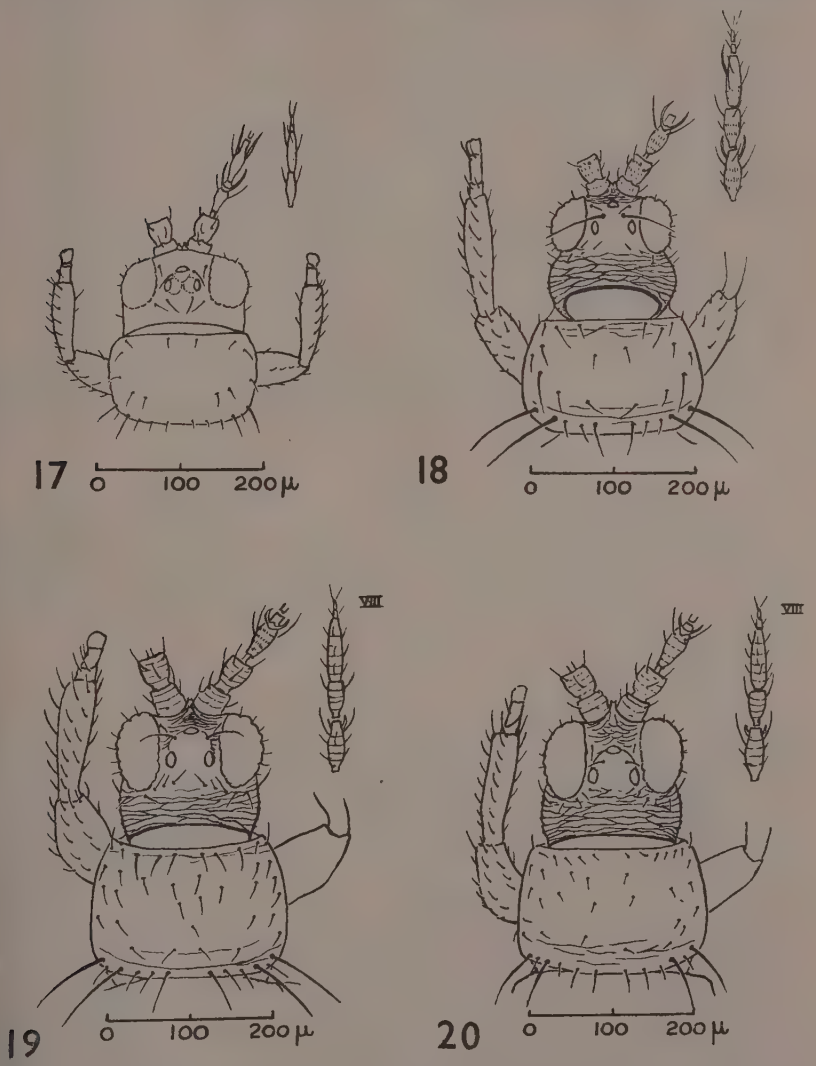
Morison (1953) recorded the capture of a larva II in a glasshouse at Cirencester, Gloucestershire and, with its wide distribution and range of hosts, this species should have a fair chance of entering glasshouses and breeding in the cooler houses.

(26) *Taeniothrips atratus* (Hal.). (Fig. 19). Carnation Thrips.

Body and legs dark brown, almost black in overwintering females ; antennae concolorous dark brown, or III very slightly paler than other segments ; fore wings dark brown, paler at base ; first vein bears usually 8 (6–13) bristles on distal half ; male lacks comb on abdominal tergite VIII ; accessory bristles present on abdominal sternites II–VII. *Length* 1·3–1·8 mm. ; male smaller.

Priesner (1926–28) described ♀, ♂, I and II; Morison (1929) prepupa and pupa of both sexes; Speyer (1951) ♀, ♂; Müller (1927) internal anatomy of immature instars; Sharga (1933) of the adults; Speyer and Parr (1941) I and II.

The recorded distribution includes most European countries and British Columbia. The species is common to abundant in most parts of Great Britain



Figs. 17–20.—Females of: (17) *Taeniothrips xanthius* (Williams). (18) *T. picipes* (Zetterstedt). (19) *T. atratus* (Haliday). (20) *T. simplex* (Morison).

and N. Ireland. It seems more numerous in N.E. Scotland than in the southern half of England and Wales and it is scarce in Shetland and the Outer Hebrides. It is probably best adapted to central and western European countries.

Larval hosts include *Capsella*, *Cerastium*, *Dianthus*, *Lychnis*, *Silene*, *Spergula*, *Spergularia*, *Stellaria*, *Statice*, certain Labiates and Compositae. I have found adults on more than 478 species of flowering plants, besides various inanimate objects. Adults generally enter glasshouses during June to September, after having been bred on wild plants in the open, and a field of corn with the weed *Spergula* can raise an immense population of adults, most of which migrate to the flowers of herbage in the vicinity. They may damage carnation and other flowers without breeding on the plants.

Speyer (1936) stated that the species entered a glasshouse in Cheshunt, Herts., from outside and attacked carnations. Anon. (1939, 1954) reports damage to *Iris* flowers out of doors at Reading, Berks., in 1936, and to annual flowers outdoors in Surrey in 1939. Speyer (1938*a*) says the species is frequent under glass and quoted the method of control recommended by Dubois for thrips in the south of France. I have seen its damage to carnations in glasshouses in various parts of N.E. Scotland. Adults tend to be most numerous on the paler coloured flowers and more numerous on senescent than freshly-open flowers.

Morison (1929) describes its life-history in the open in N.E. Scotland, and (1943) its distribution and habits in Britain. Females are often killed by a fungus in the autumn. Bagnall in 1914 recorded a Chalcid parasite associated with the insect in the open.

(27) *Taeniothrips dianthi* Priesner. Dianthus Thrips.

Abdomen dark brown, head and thorax a little paler; antennal segments mostly brown, except III which is yellow with strong dark bristles, whilst VII–VIII form a long slender style. Fore tibiae and all tarsi yellow, second and hind tibiae dark coloured in middle; fore wings dark brown, paler at base and bearing only 2 bristles on distal half of first vein; abdominal tergite VIII of female bears strong comb. *Length* 1·0–1·2 mm.; male smaller.

Priesner (1926–28) described ♀ and II; Bagnall (1933) ♂; Pelikan (1951) ♀, ♂, egg, I and II, and called it the " Carnation Thrips "; but, as this name has been used previously for *T. atratus*, it may be convenient to call it the " Dianthus Thrips ", as I have done above.

Recorded from Dalmatia, Austria, France, Italy, Spain, Andorra, Moravia, W. Poland, Slovakia, Morocco, Egypt, Iowa and British Columbia, it is probably native to central and southern Europe.

Priesner recorded the species as associated with leaf-curl of *Dianthus caryophyllus* in the open in Lower Austria and on *D. carthusianorum* in Upper Austria and Dalmatia. Bagnall found females on *D. carthusianorum* in France, Andorra and Spain and (1933) on other species of plants in Italy. Raymond, calling it *Physopus pallipennis* Uzel, found it in 1924 as one of the pests of carnations in glasshouses in the French Riviera where Pussard (1946) described its control. Pelikan (1951) dealt with bionomics and life-history in the open in Czecho-Slovakia. It has not been recorded for the British Isles but its recorded geographical distribution suggests possible introduction.

(28) *Taeniothrips simplex* (Morison). (Fig. 20). Gladiolus Thrips.

Body dark brown; antennae dark brown, except III which is paler yellowish-brown, and IV, V each with a pale ring near the base; legs dark brown, except ventral surface and apex of fore tibia and apices and middles of other tibiae and all tarsi, which are paler yellowish-brown; fore wing brown except for pale area near base. *Length* 1·3–1·7; male smaller.

Morison in 1930 described ♀ on carnations from S. Australia and (1951) figured ♀, ♂ and II; Moulton and Steinweden in 1931 described ♀ and ♂ from gladioli in Ontario, Canada, as *Taeniothrips gladioli* sp. n.; Smith and Nelson (1933) described immature stages briefly; Speyer (1951) ♀ and ♂.

Its native land is unknown but probably one with a Mediterranean or warmer climate. The insect has apparently been spread by commerce and has been recorded from S. Australia, New South Wales, Victoria, many regions of Canada and U.S.A., Argentina, three Hawaiian islands, Bermuda, Jamaica, S. Africa, S. Rhodesia, Turkey and Europe, where the history of its spread is described by Titschack (1952). British records are Speyer (1950), Anon. (1950), Skillman (1950), Aitkenhead (1951) and many unpublished reports by advisory entomologists in the N.A.A.S. of England and Wales. It has been introduced to south Scotland. Breeding occurs in the open in England but it seems still unproven if the insect can hibernate in the open.

Hosts include *Gladiolus*, *Tritonia*, *Freesia*, *Tigrida*, *Kniphofia*, *Iris*, *Canna* and Carnation. Damage is usually reported on *Gladiolus*, and carnations suffer in some parts of the U.S.A.

Life-history, bionomics and control in the U.S.A. are described by Herr (1934), Bailey (1938) and others, and in Canada by Dustan (1935). Watson, in 1941, reported the raising of 20 complete generations in Florida and only males developed from unfertilised eggs. Bournier (1956) dealt with oogenesis, spermatogenesis and parthenogenesis.

(29) *Taeniothrips vulgatissimus* (Hal.). (Fig. 21). Thrips.

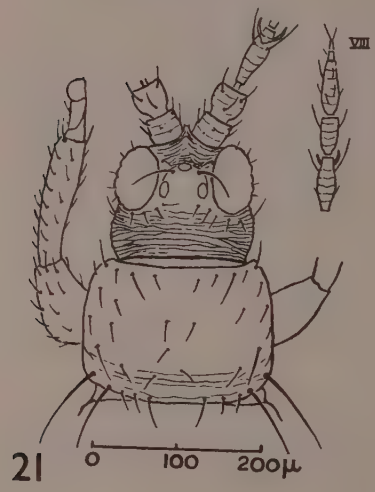
Body dark brown, but young adults yellow with areas of cuticle more or less shaded with brown or grey, and at least end of abdomen dark; antennal segment III pale yellowish-brown, IV brown, others darker brown, III about 3 times as long as broad, longer than VI, vase-shaped, constricted into a neck before the apex; legs more or less concolorous with the body; wings pale yellowish-brown, first long vein usually bears 3 (may be 4–6) bristles on distal half; accessory bristles present on abdominal sternites III–VII; no comb on tergum VIII of male. *Length* 1·3–1·8 mm.; male smaller.

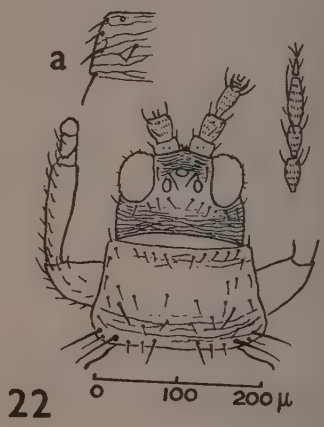
Uzel (1895) described ♀ (as *Physopus pallipennis* sp. n.); Priesner (1926–28) ♀, ♂, II; Morison (1929) I, prepupae, pupae, life-history in open in N.E. Scotland, and (1943) habits; Speyer and Parr (1941) II; Klocke (1926—as *Thrips vulgatissimus* Hal.) anatomy and histology; Sharga (1933) internal anatomy of ♀, ♂; Speyer (1951) ♀, ♂.

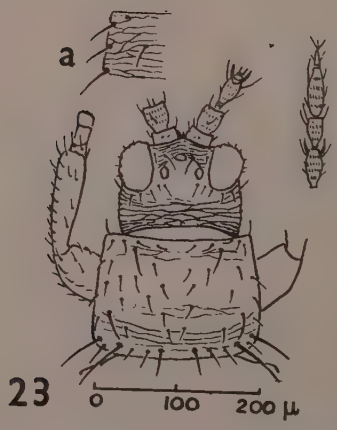
It is recorded from most European countries, Siberia, California, British Columbia and New Zealand, and is probably best adapted to the mountains of west and central Europe, where it experiences a colder climate than the normal

of the latitude. Distributed throughout Britain, it is apparently more numerous in the east than the west and most abundant in N.E. Scotland, less so in the north and scarce in the Shetland Islands and Outer Hebrides ; it becomes reduced in numbers as it advances south where it is scarcer, though not rare. It is fairly common in N. Ireland. As remarked above when discussing parthenogenesis, the sexes occur in about equal numbers in Scotland, but males are scarce or absent in Wales and the southern part of England.

The larval hosts include certain species of Crucifers, Umbellifers, Salicaceae, Papilionaceae, Rosaceae, Linaceae, *Rumex*, *Ribes*, *Rhododendron* and *Ulmus*,







FIGS. 21–24.—Females of : (21) *Taeniothrips vulgatissimus* (Haliday). (22) *Thrips fuscipennis* Haliday ; (*a*) abdominal tergite II. (23) *T. major* Uzel ; (*a*) abdominal tergite II. (24) *T. tabaci* Lindeman.

most of which are common in south as well as north Britain, so that the distribution and abundance of hosts does not limit the numbers of the insect. I have found the species on more than 411 species of plants as well as on inanimate objects. Damage in the open includes whitish spots or streaks on the petals of flowers and more or less extensive bleaching of green stems, leaves and fruit.

T. vulgatissimus occurs infrequently under glass (Speyer, 1938*a*); I found it (I, II, pupa and ♀) on *Nepeta* in a glasshouse in Stornoway, Lewis. In Scotland adults are frequently carried into glass and dwelling houses with flowers cut in the open. Fungus in the autumn kills many females.

Raymond's *Physopus pallipennis* Uzel attacking pinks near Antibes, France, in 1924 and Pussard's (1933) *Taeniothrips vulgatissimus* Hal. on carnations under glass, are *T. dianthi*, according to Pussard (1946).

(30) *Thrips fuscipennis* Haliday. (Fig. 22). Rose Thrips.

Body dark brown in old female, yellowish-brown in young, with apex of abdomen dark; antennae brown, III and IV yellowish-brown, scarcely paler than the others, especially in older insects; legs brown; fore wings dark greyish-brown, paler at base, first long vein bears 3 (rarely 2) bristles on distal half; abdominal tergite II (fig. 22) bears 4 setae along side margin; abdominal sternite I with a pair of minute setae. *Length*: 1·2–1·6 mm.; males smaller, usually paler.

Ahlberg (1924) described immature instars; Priesner (1927–28) ♀, I, II, prepupa, pupa, and (1933) ♂; Speyer (1932, 1933) wrote that the ♂ was separable from that of *major* on morphological characters and published on these characters (1934), *cf.* Priesner (1934); Speyer and Parr (1941) described I and II.

It is widely distributed in Europe and probably native to its western countries. Hood recorded it from two places in New York State. In Britain it is more abundant on the east than the west and in the south than the north. Abundant in S.E. England, it reaches, in smaller numbers, the southern boundary of the Highland Border Fault which runs across Scotland from the mouth of the Clyde to Stonehaven. North of this line it seems checked by climatic factors, for, though occurring as far north as Easter Ross-shire, it seems to have been introduced to the region with fruit trees and to be confined to gardens, in which it reaches its maximum numbers later in the year. In Ireland I found it in counties Armagh, Antrim and Down; K. G. V. Smith records it from Wicklow.

Larval hosts include *Althaea*, *Asparagus*, *Chenopodium*, *Fragaria*, *Fraxinus*, *Mentha*, *Prunus*, *Rosa*, *Rubus* and *Ulmus*. I have taken adults on more than 298 species of flowering plants in the open in Britain and damaging peach leaves in glasshouses in N.E. Scotland. The plants attacked show bleaching and other signs of damage by thrips. Females overwinter on trunks of trees and amongst herbage; pupation occurs in shelter on vegetation or in soil.

For glasshouse plants Ahlberg (1924) described damage to roses and control in Sweden; Speyer (1932) damage to roses and cucumbers (the female laying about 50 eggs), sites of laying on rose and control, (1933) control on rose and other cut flowers, and (1936) control on roses; Orchard and Read (1937) control on roses with tables of percentage injury to blooms; Orchard, Read

and Speyer (1938) bionomics, control; Speyer (1939) bionomics, flight, control, and (1940) bionomics, control, damage to strawberry plants; Staplehurst (1946) bionomics and control; Miles and Miles (1948) life-history, habits, plants attacked and control; Morison (1943) habits and bionomics in the open.

(31) *Thrips major* Uzel. (Fig. 23). Rubus Thrips.

Female pale to dark brown, thorax more reddish-brown than abdomen, apex of which always dark in young insects; head 1·4–1·6 times broader than long; antennae brown, III and base of IV paler than the rest; legs brown; fore wing pale yellowish-brown with 3 bristles on distal half of first long vein; abdominal tergite II bears 3 setae along side margin (fig. 23); no setae on abdominal sternite I; other sternites without accessory bristles. *Length* 1·1–1·5 mm.; male smaller, often paler.

Priesner (1927, 1928) described ♀, (1933) ♂; Speyer (1934) ♀, ♂; Speyer and Parr (1941) I and II.

Widely distributed in Europe and probably best adapted to its central region, it is more numerous on the east than the west of Britain and most numerous in the south, becoming scarcer as it advances north to its north-west limit which seems to lie in Midlothian and Lanarkshire; it seems scarce in Wales. In Ireland I have taken it in counties Down, Antrim and Armagh; K.G.V. Smith records it from Wicklow and Dublin.

One or both sexes may occur in abundance on flowers in the open, often associated with adults of one or more species of other flower-frequenting thrips, *Thrips fuscipennis*, *T. flavus*, *Taeniothrips atratus*, *Ta. vulgatissimus*, and casuals like *Frankliniella intonsa* and *Aeolothrips* spp. I have found the insect on more than 221 species of plants in the British Isles. Larval hosts include *Chamaenerion*, *Crataegus*, *Galium mollugo*, *Hydrangea*, *Prunus*, *Rosa*, *Rubus*, *Rumex*, *Sanguisorba*, *Lathyrus* and *Vicia*. Damage to flowers in the open by adults is usually limited to bleached spots and streaks on the petals and to bleaching of small areas of green tissue by larvae. It is found only rarely under glass and then only in late summer (Speyer, 1933). Morison (1943) gives a brief account of its life-history. It apparently overwinters as an adult female under bark and in other dry sheltered places (Uzel, 1895). Probably two generations occur in the year in the southern half of England. Pupation is usually in soil below the host plant.

(32) *Thrips tabaci* Lindeman. (Fig. 24). Onion Thrips.

Coloration varies from pale yellow with brown pigment more or less developed in sclerites of head, thorax and abdomen and often forming bands across the abdomen, to dark brown, with thorax more yellowish-brown than abdomen, the apex of which is always darker than some of the preceding segments in young insects; antennae, I hyaline, others yellowish-brown with bases of III–V paler; legs yellow, shaded with brown; fore wing concolorous pale brownish-yellow, with distal half of first vein bearing usually 4 hairs, evenly spaced; pronotal bristles 33–45 μ long; comb on VIII abdominal tergite, complete dorsally; no accessory bristles on abdominal sternites; ocellar crescents greyish-yellow. *Length* 1–1·3 mm.; male smaller, paler.

Priesner (1927) described ♀; Speyer (1934) ♀, ♂; Speyer and Parr (1941) I, II; Petersen (1915) anatomy of head and mouth parts; Sharga (1933*a*) ♀

internal anatomy: Bonnemaison (1939) mouth parts of larva and ♀; Ghabn (1948) ♀, egg, I, II, prepupa and pupa with a coloured plate.

Probably native to most of the warmer parts of the palaearctic and nearctic regions, it seems to have been spread by commerce and is now practically cosmopolitan in distribution. (*cf.* Distribution Map No. 20, Commonwealth Institute of Entomology, London, 1952). It is widely distributed in the British Isles and abundant in restricted localities. Adults do not frequent flowers in numbers with other species of thrips. It is often of considerable economic importance to plants during dry weather in the open in temperate and subtropical regions.

The commonest British glasshouse thrips, it is recorded from many different species of plant in England and Wales and is probably as common in Scotland. It was described in 1888 by Lindeman from Bessarabia, but, assuming that it has not varied much in distribution and abundance in the British Isles during the last 150 years, I interpret the older British writers as follows: Major (1829), without mentioning genera or species, seems to have included it with other species in his description of "Thrip" damage and control: Curtis's confusion of yellow females under the name of *ochraceus*, with the orange-yellow females of *flavus* is described under this species. He also called the darker females (including yellow females shaded with brown, according to his own account and to Westwood, 1880) *minutissima* L., for, writing as Ruricola (1841), he described and figured his *T. ochraceus* on fruit trees out of doors in England and, writing as Curtis (1845), said that *ochraceus* swarmed on peaches and other wall fruit as well as on melons, etc. in frames, whilst, as Ruricola (1846), he described and figured *minutissima* L. (*tabaci* Lind. *mihi*) damaging potato leaves in Oxfordshire. The observations were reprinted in his *Textbook* in 1883. The anonymous author who (1841, *Gardener's Chronicle* 1 : 521) described methods of controlling thrips in melon pits was almost certainly Curtis, and if the insects concerned were *tabaci*, this is the first mention of damage by this species (long before it was described in 1888). *T. minutissimus* does not breed on potato plants and its adults and larvae are easily separated morphologically from those of *tabaci*.

Fulmek (1911) described damage to carnations in a glasshouse in Lower Austria by *flavus* named by Karny, but this is *tabaci* from Fulmek's illustrations and the habits of the species.

Females have been recorded from many hundreds of species of plants in different parts of the world (*cf.* Ghabn, 1948), and I have found the insect on more than 355 species of flowering plants and two ferns in the British Isles. Males are usually absent. Their existence seems favoured by heat and a dry atmosphere, and they may be abundant in some places. Their association with parthenogenesis has been discussed earlier. Larval hosts include many species of Dicotyledons and Monocotyledons. The attacked area is bleached and growth may be checked. The effect on the cotton plant has been described in detail by Wardle (1927), Wardle and Simpson (1927) and MacGill (1927–37). Adults of both sexes are capable of jumping and they fly under stimulus of sunlight and a temperature of about 80° F. Pupation usually occurs in soil, less often on plants. Two generations occur in the year with much overlapping of the stages in N.E. Scotland in the open. Bonnemaison (1939) found five to six generations in the open in central and southern France. Under glasshouse

conditions 12 generations have been bred in the year. Its life-history in the open and under glass has been described by Wardle (1927), Wardle and Simpson (1927), MacGill (1927–37) and Speyer (1932) for England and Ghabn (1948) for Egypt.

Its transmission of the virus of Spotted Wilt of tomatoes in England has been discussed by many people, including Jarrett (1930), Smith (1931, 1935), and Speyer (1934); Bailey (1935) and Sakimura (1947) discuss its transmission of different virus diseases of plants in various parts of the world. The breeding of onions resistant to the insect is considered by Jones, Bailey and Emsweller (1934), and Bailey (1941).

Control under glass is dealt with by Allwood (1920), Miles (1926, 1926*a*), Miles and Miles (1948), Speyer (1932, 1938, 1938*a*), Staplehurst (1945), Wilson (1950) and a host of authors from foreign countries.

Various predators and parasites have been recorded from different countries (*cf.* Ghabn, 1948). MacGill (1939) described a predacious Parasitid under glass in England.

(33) *Thrips angusticeps* Uzel. (Fig. 25). Cabbage or Field Thrips.

Body dark brown, head 1·1–1·3 times broader than long; antennae brown, III paler, yellowish; legs dark brown with fore tibiae and all tarsi yellow, shaded brown; first vein of macropterous fore wing bears 3–6 bristles on distal half, but wings may be micropterous in both sexes; 4 pairs of hairs between innermost long bristles on posterior margin of pronotum; accessory bristles present on abdominal sternites II–VII. *Length* 1–1·3 mm.; male smaller.

Van Eecke (1922) described and figured ♀, ♂, II; Priesner (1927) ♀, ♂, egg, II; Speyer and Parr (1941) I, II; Doeksen (1941) external anatomy of adults.

It is recorded from many European countries (probably best adapted to central and western Europe) and also from Egypt and Persia. I have named the species for the Commonwealth Institute of Entomology from Asiatic Turkey. Apparently much commoner on the east than the west of England, it is perhaps most abundant in Norfolk, Suffolk, Essex and Kent, and occurs in Somerset, Cardigan, Caernarvon, Cheshire and various intermediate counties. It seems very scarce, if not absent, north of Cheshire, and in Scotland is known only from a restricted locality in Aberdeen to which it was probably introduced accidentally.

Adults occur on many species of plants. Larval hosts include kohlrabi, cabbage, Brussels sprouts, mustard, *Lepidium sativum*, *Thalaspi arvense*, *Taraxacum*, flax and perhaps swedes, beet and peas. It is occasionally of economic importance to crops in the open in England; Jary (1934) reported damage to Brussels sprouts seedlings in Kent, and Gough (1955) to peas in East Anglia. Being fairly widespread, locally abundant and frequenting a large number of species of plants, the insect could be expected to occur sometimes in glasshouses in the southern half of England.

Morison (1943) reported probably two generations in southern England. In 1944 I found it breeding in abundance on flax in E. Anglia. Ahlberg (1924) described damage to kohlrabi in Sweden and depicts some of the instars, Buhl (1934) its life-history and control in Schleswig-Holstein on cabbage.

(34) *Thrips flavus* Schrank. (Fig. 26). Honeysuckle Thrips.

Orange-yellow, not shaded with grey or brown at apex of abdomen; antennae yellow, III–V shaded brown at apex, VI–VII brown; postero-angular bristles of pronotum about 84 μ long, about two-thirds length of pronotum; legs yellow; fore wing pale yellow. *Length* 1·2–1·6 mm.; male smaller, paler.

Priesner (1923*a*) described II, (1927) ♀, ♂ egg and II; Speyer (1934) ♀, ♂; Speyer and Parr (1941) I, II. Bagnall in 1928 described a ♀ and ♂, as *Taeniothrips flavus* sp. n., since each had an extra segment in the antennal style, but this seems unnecessary, as Priesner remarked in 1938.

A new synonym is, I believe, *Thrips ochraceus* Ruricola (1841) (J. Curtis), who figured and described briefly the female on plums in the gardens of the Horticultural Society (also on nectarines and peaches) and its control with flowers of sulphur applied by bellows. His later reference to this new species (Curtis, 1845) probably included *T. tabaci*, as he describes its occurrence not only on peaches and other wall fruits, but also on melons and cucumbers, which are more frequently attacked by this species than by *T. flavus*. Westwood (1880) referred briefly to *ochraceus* Curtis. 1841. Uzel (1895) mistakenly attributed the description of *ochraceus* to Westwood, 1839, and this mistake has been repeated by later writers.

Fulmek's (1911) *flavus* on carnations is apparently *tabaci*. *T. flavus* is not predacious, though various authors record it as such on red spider mites on cotton and hops in central and eastern Europe. The thrips of these authors are probably *Scolothrips* spp. Abstracts of the papers are published in the *Review of Applied Entomology*.

This species is probably best adapted to central and eastern Europe, but is recorded from most European countries, Siberia, Turkestan, Nyasaland and New York State. Distributed over most of Great Britain it may be abundant locally, and is more numerous in the east than the west and the south than the north; it is also recorded from Dublin and N. Ireland.

Larval host plants in the open include *Aster*, *Beta*, *Lonicera periclymenum*, *Malva*, *Rubus*, *Salvia*, *Sambucus*, *Senecio*, *Ulex* and *Verbascum*, and I have found adults on more than 245 species of flowering plants in Britain. Under glass it has been recorded as damaging begonias in Norway; Speyer in 1926 describes injury to foliage of cucumber in Hertfordshire. The attacked surface of a plant becomes silvery and covered with faeces which may appear brown through infestation by brown fungi. The species has been suspected of transmitting the virus of mosaic in *Vicia faba* in Germany (*cf.* Bailey, 1935).

Two generations occur in the year in N.E. Scotland: pupation is in the soil and the females overwinter. Its life-history and bionomics have not been described in detail, but van Eecke (1922) dealt with development, habits and damage, Priesner (1923*a*) damage by larvae, Theobald (1926) damage to American blackberries in Kent, and Morison (1943) gives a brief account of its bionomics.

(35) *Thrips nigropilosus* Uzel. (Fig. 27). Chrysanthemum Thrips.

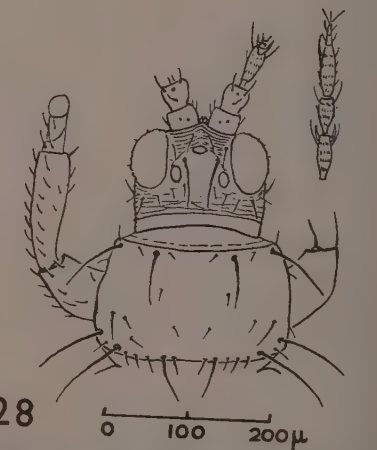
Body yellow; brown or grey pigment more or less present in sclerites of head, thorax and abdomen, of which apex not darker than rest; bristles brown; antennae brown, but III and base of IV may be paler and I is yellow; postero-angular bristles of pronotum

little longer than half its median length ; fore wing pale yellow, but wings may be more or less reduced. *Length* 1·1–1·4 mm. ; males smaller, micropterous, not recorded for the British Isles.

I consider var. *laevior* Uzel the hemimacropterous female and var. *umbrata* Priesner the overwintering female.

Priesner (1927–28) described ♀, ♂, I, II, prepupa and pupa, (1923) I, II ; Speyer and Parr (1941) I, II.

This species, recorded from most European countries, is probably native to Europe and perhaps also to much of the U.S.A. and Canada, to which it is considered as introduced. Priesner considers it introduced to Egypt, and



Figs. 25–28.—Females of : (25) *Thrips angusticeps* Uzel. (26) *T. flavus* Schrank. (27) *T. nigropilosus* Uzel. (28) *Frankliniella intonsa* (Trybom).

Sakimura to the Hawaiian Islands. I have named the species for the Commonwealth Institute of Entomology from New South Wales and the Fiji Isles. The only record for Britain was one female taken by C. B. Williams amongst wheat at Merton, Surrey, in 1915, until Speyer (1935) described damage to chrysanthemums in a glasshouse in Kent. Between 1925 and 1955 I found the insect in the open in a total of 144 localities in 12 English, two Welsh and nine Scottish counties, from Devon and Kent to Glamorgan, Caernarvon and Ross-shire.

Unlike Priesner (1927–28), who found it the most numerous species of thrips after *tabaci* amongst grass and apparently fairly common amongst other small flowering plants in Austria, I have in Britain found females only in very small numbers on plants other than *Plantago lanceolata* and *P. maritima*, on which it breeds. It may cause much damage to both sides of the leaves and leaf stalks of *lanceolata*, especially when the plants grow in a dry habitat. Females walk quickly and are capable of jumping about 1 cm. high. The colony may include dozens of females and hundreds of larvae and, if they have harmed the hosts greatly, the insects migrate when they are mature, except for a few micropterous females. The females of a colony may show all degrees of wing development from macroptery to scale-like microptery. All forms of females overwinter. Macropterous females seem a little smaller than micropterous. Pupation usually occurs in the soil under the plants. There are apparently two generations in the year in N.E. Scotland, with females all the year round and larvae from May to November.

Under glass Speyer (1935) recorded brachypterous adults (presumably only females) damaging chrysanthemum cuttings in Kent; van Eecke (1922) *Gloxinia* in Holland; Ahlberg (1924) Cucurbitaceae and chrysanthemums in Sweden; Hood (1927) chrysanthemums and, with Herrick (1928), on castor oil plant, mullein and lemon verbena in New York State, and on lettuce in New Jersey; Bailey (1940) on glasshouse plants in U.S.A.; Andison (1953) on chrysanthemum in British Columbia. Sakimura (1939) discussed its position in Hawaii and (1947) stated that it does not transmit certain virus diseases of plants. It is generally of minor importance under glass. The life-history and bionomics have not been described in detail.

An interesting subject for investigation would be why the species does not breed on *Plantago major*, *P. media*, *P. coronopus*, which are common plants in many places where I have found it breeding, and why it does not breed on plants of other families in the open in Britain when it breeds on them to the extent of injury under glasshouse conditions.

Control is discussed by Speyer (1935) in Britain, McCauley (1939) in Illinois, and Smith and Goodhue (1945) in Maryland.

(36) *Frankliniella intonsa* (Trybom). Fig. 28. Flower Thrips.

Body yellowish or reddish-brown; antennal segments I, II and VI–VIII dark brown, III–V yellow with IV, V shaded brown near apices; legs brown with all tarsi yellowish; wings pale yellowish-brown. *Length* 1·2–1·8 mm.; male smaller.

Priesner (1927–28) described ♀, ♂, immature instars; Speyer and Parr (1941) I and II.

During 1895–1912 the species was generally called *Physopus vulgatissimus* Hal. It received the name " Flower Thrips " chiefly because some other species in its large genus are called by that name, each with its particular prefix, in the U.S.A. from their habits of frequenting flowers in considerable numbers (*cf.* Taylor and Smith, 1955). For many parts of the European continent the name is justified on account of its numbers and habits, for Priesner (1927–28) remarks on its abundance and that it frequented more than 150 species of plants in Austria, but I have found it on only 81 species in Britain and not in the numbers and frequency of the British flower-haunting thrips, *Thrips fuscipennis*, *T. major*, *Taeniothrips atratus* and *Ta. vulgatissimus*. It is reported from most European countries, Greenland, Siberia and the Pacific sea board region of Asia, where it has been recorded as *formosae* Moulton, according to Sakimura (1956). Perhaps it is best adapted to a climate like that of parts of Central Europe. In Britain it is more numerous on the east than the west and in the south than the north, and not uncommon in S.E. England.

In N.E. Scotland females hibernate amongst vegetation and in spring they may assemble in fairly large numbers on flowers of different species of plants which are not larval host plants but which happen to grow near the latter. As the year advances both sexes may be found in small numbers on the flowers of larval host and other plants. There are apparently two generations, with males appearing in each. Males appear in early June and disappear during October. The species breeds in greatest numbers in marshes on *Erica tetralix*, *Pedicularia sylvatica* and some other marsh plants, but it can multiply on *Rosa*, *Ononis* and other plants in drier habitats. Pupation occurs on the plant, as is usual for thrips breeding on bog plants with roots covered by water.

It is apparently a casual visitor to glasshouses but there is no record of its breeding therein. I received a female from a glasshouse at Rothamsted Experimental Station, Harpenden, Herts., and another from France.

It is of little economic importance to plants in the open, though Hukkinen and Surjänen in 1941 recorded considerable damage to young apple trees in Finland ; van Eecke (1922) described its life-history in Holland, and Hardy and Milne (1938) its carriage by aerial currents to a height of 250–2100 feet in Yorkshire ; it seemed not to transmit the virus of Spotted Wilt experimentally near Bordeaux on dahlia, tobacco and tomato, according to Bonnemaison (1937) and Sakimura (1956) confirms this finding.

(37) *Parafrankliniella verbasci* Priesner. (Fig. 29).

Body dark brown or yellowish-brown ; antennae brown, III yellow ; legs brown ; fore wing hyaline at base, dark in middle, paler at apex ; numerous accessory bristles besides row of 6 near hind margin on each abdominal sternite III–VII. *Length* 1·4–1·7 mm. ; male smaller.

Priesner (1927–28) described ♀, ♂, II.

It is recorded from many European countries, including southern England. I have found both sexes in the open at Kew Gardens, Surrey, and at Chelsea Physic Garden, London. It is probably native to the Mediterranean region, where abound numerous species of *Verbascum* on which it breeds, and on which it may be able to establish itself in glasshouses.

Its life-history and bionomics are undescribed.

(38) *Kakothrips robustus* (Uzel). (Fig. 30). Pea Thrips.
(*Frankliniella pisivora* Westwood).

Body very dark brown ; antennae brown with at least III yellow ; fore tibiae and all tarsi yellowish ; fore wing dark brown, hyaline at base. *Length* 1·5–2 mm. ; males smaller.

Priesner (1927–28) described ♀, ♂ and immature stages ; Speyer and Parr (1941) I, II ; Doeksen (1941) external structure of adults ; Sharga (1933) internal anatomy of II.

It is recorded from most European countries, Siberia and Palestine. Apparently native to Europe, it is probably best adapted to the drier, warmer conditions of the continent. Widely distributed in England and Wales, it is also recorded from Kirkcudbright and is probably present in other southern counties of Scotland. Dr. J. Carroll tells me that it occurs in south Ireland.

Adults have been found on many species of plants, particularly Papilionatae, of which several species are larval hosts. It is an important pest of peas in many European countries. One generation occurs in the year and the adult larva overwinters in the soil. Williams (1915) described its life-history and bionomics in England, Buhl (1936) in Germany and Kutter (1936) in Switzerand. Hardy and Milne (1938) noted the distribution by aerial currents of both sexes near Hull (Yorkshire) and Freeman (1945) recorded the heights at which it was captured in the air in Lincolnshire. The tolerance of different degrees of temperature has been described by some of the above-named authors, but a detailed study has not been made of the effects of temperature and relative humidity on the different instars ; nevertheless the insect seems likely to be able to breed in cooler glasshouses on certain Papilionatae. Speyer (1941) recorded a single larva II on Cyclamen in a glasshouse in Hertfordshire, England.

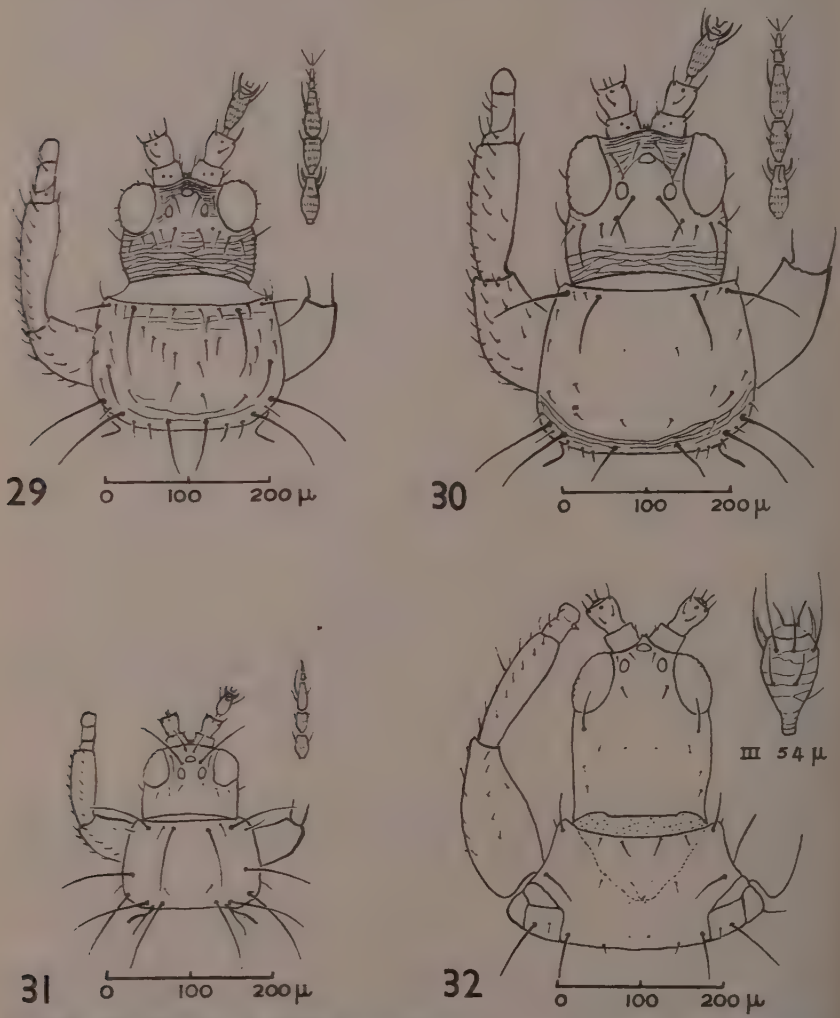
(39) *Scolothrips sexmaculatus* (Pergande). (*cf.* Fig. 31).
Six-spotted Thrips.

Body and legs pale whitish-yellow with pale grey shading on pro-, meso- and metanotum ; antennae I, II and base of III pale yellow, IV–VIII shaded grey ; fore wing pale, with single grey spot on basal half of scale, near base of second long vein and about two-thirds of distance from base. *Length* about 0·9 mm. ; male smaller. For coloration the insect should be examined against white paper by reflected light.

Earlier records include various species under *sexmaculatus*, e.g. larva II of Speyer and Parr (1941) may be this species or *pallidus* (Beach), of which the female is depicted in my figure 31. According to Priesner (1950), who describes the male and female, *sexmaculatus* has not been found outside the U.S.A., where it has been confused with *pallidus*, but species of the genus have been recorded from Europe, Brazil, Hawaiian Islands, India, S. Australia, Egypt, Asia and Pacific Islands.

Scolothrips spp. have long been known to feed upon Red Spider mites (Tetranychidae). Newcomer and Yothers in 1929 observed that one larva II instar consumed 55 eggs, 34 larvae, seven nymphs and possibly six adults of *Paratetranychus pilosus* C. and F. in three days in Indiana. Mahoney in 1930 suggested that it might be possible to breed the thrips in the laboratory in

winter in sufficient numbers to give, in spring, effective control of red spider mite on vines in the open in California. Speyer (1938) liberated adults, received from California, on carnations infested with *Tetranychus telarius* L. during October, 1937. in a glasshouse at Cheshunt, England, but no signs of increase were observed and they seemed to die out later. Bailey (1939), in California, found that the species was a slow reproducer, winter being survived by adults.



FIGS. 29—32.—Females of: (29) *Parafrankliniella verbasci* Priesner. (30) *Kakothrips robustus* (Uzel). (31) *Scolothrips pallidus* (Beach). (32) *Haplothrips fuliginosus* (Schille).

B. **Tubulifera, Phlaeothripidae.**

(1) *Haplothrips* (*Xylaplothrips*) *subterraneus* Crawford, J. C. (*cf.* Fig. 32).

Body dark brown; antennae dark brown except pedicel of III and basal fourths of IV–VI, which are yellowish; segment III almost bilaterally symmetrical in dorsal view, bearing 3 simple sense cones; legs dark brown except for yellow tarsi and yellowish shading on fore tibiae and extreme base and apex of middle and hind tibiae; fore wings slightly clouded throughout. *Length* 2·2 mm.; male smaller.

The species was described by Crawford (1938) from macropterous ♀♀ and ♂♂ intercepted on lily bulbs from England, and by Kurosowa (1938), as *Trichothrips liliorus* sp. n., from Japan and Korea, also on lily bulbs. Kurosowa recognised the synonymy by manuscript notes in a reprint he sent to me of the description. Morison (1949) considered that the larvae, and perhaps the adults also, are much more likely to be predacious on *Liothrips vaneeckei*, which infested the lily bulbs examined by the authors, than to be harmful to the lilies. There is no locality record for the British Isles. The species quite closely resembles *fuliginosus* (Schille) (fig. 32), which is widespread and fairly common in Britain.

(2) *Aleurodothrips fasciapennis* (Franklin). (Fig. 33). White Fly Thrips.

Head and prothorax yellowish-brown, pterothorax paler; abdomen yellowish-brown, palest at base, dark brown on segment VI, with V and VII darker than other segments but paler than VI; antennae I–III pale yellow, IV–V yellow, tipped brown, VI–VIII dark brown; fore legs yellowish-brown, shaded darker brown on outer surfaces; mid and hind femora yellow with brown band near apices, tibiae and tarsi yellow; wings pale brown with a narrow hyaline area just beyond scale, a wider one before the middle and a third just before the apex; mouth-cone rounded at apex. *Length* about 2 mm.; male smaller.

Unaware of Franklin's description of the species in 1908, Bagnall described it in 1909 as *Cephalothrips spinosus* sp. n. from an adult (sex not stated) found on a leaf of *Strelitzia nicolai* in a glasshouse in Brussels, Belgium. He remarked (1909*b*) that it can scarcely yet be regarded as a true hothouse species, being described from a single specimen. In 1914 he erected for it the genus *Microcanthothrips*, illustrated by an outline drawing of the fore leg, of which the spine on the femur could represent that of a male *Aleurodothrips fasciapennis*. Priesner (1949) considered *A. fasciapennis* (Franklin) to be identical with *M. spinosus* Bagn. and Bagnall's description is consistent with this interpretation.

It is recorded from Barbados, Bermuda, Jamaica, Florida, Cuba, Nassau, Louisiana, Ceylon, Formosa, China and Java, and has been introduced deliberately to Fiji and accidentally to Brussels and New York.

Both adults and larvae are true predators of Aleurodids, the adult female and the crawling stages of Scale Insects. The species was introduced from Java to Fiji for the control of *Aspidiotus destructor* on coconut palms, and in 1938 J. C. Crawford recorded it as abundant amongst hemispherical and diaspine scales on palms in greenhouses of New York Botanical Gardens.

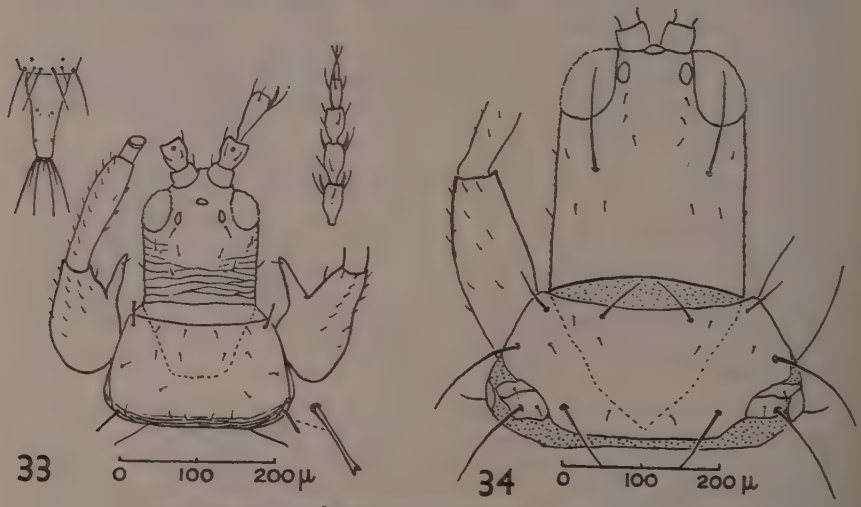
(3) *Liothrips vaneeckei* Priesner. (Fig. 34). Lily Thrips.

Body dark brown; all tarsi, apices of fore femora, bases of middle and hind tibiae orange yellow; fore tibiae orange yellow, shaded brown in middle; apices of middle and

hind tibiae paler brown than middle; fore wing darker than hind wing, but each pale brown. *Length* 2·0–2·5 mm. (females); 2·0–2·2 (males).

Van Eecke (1922) described and figured adults and most of the immature instars and his descriptions of the last were used by Priesner (1926) and again when the latter (1927–28) described the adults. All stages are described briefly by Schopp and Doucette (1932) and Hodson (1935).

It is recorded in the open from many European countries, India, Ceylon, China, Japan, Canada, many States of the U.S.A., Mexico and New Zealand. Priesner (1927–28) recorded adults on wild plants in the open in Austria and Elba, so that it may be indigenous to certain regions of Europe. Bailey (1939) considered it probably indigenous to parts of the U.S.A. In England it is harmful to bulbs under glass and in the open, but it was apparently



Figs. 33–34.—(33) Male of *Aleurodothrips fasciatus* (Franklin).
(34) Female of *Liothrips vaneeckei* Priesner.

introduced. Bagnall, in 1933, recorded specimens from lily bulbs from London; Hodson (1935) from Buckinghamshire in November, 1933. Anon. (1936, 1939, 1954) mentioned its locations in England and damage to lilies. The insect has been found in one locality in Scotland.

Host plants include *Lilium canadense*, *L. carolinianum*, *L. longiflorum*, *L. martagon*, *L. pardalinum*, *L. regale* and *L. washingtonianum*, and Priesner records it from "Rasen". Damage to lily bulbs may be severe, but the aerial parts of the plant are not attacked. Control is fairly easy and is discussed by Hodson (1935), Miles and Miles (1948—who state that the insect is also found on orchids), Staplehurst (1946) and Bailey (1940—who describes it as of minor importance in the U.S.A.).

Schopp and Doucette (1932) studied the life-history in the U.S.A. Hodson (1935) reared it on *Lilium regale* and *L. longiflorum* in the laboratory in England. He found it gregarious, breeding between the scales of the bulb

where the eggs are laid. It overwinters as an adult and larva II, from November to March, and has at least four generations in the year and probably seven under favourable conditions; its spread in the field seems slow. Although adults have not been seen to fly, I have seen those of both sexes of the closely allied *L. setinodis* (Reuter) (= *hradecensis* Uzel, Priesner) flying readily in the open in warm sunlight during June and July. At 55° F. and above the thrips become very active but are torpid below 40° F. Between 58–65° F. the egg stage lasts 14 days, larva I 9, II 11, prepupa 2, and pupa I and II 8 days. Eggs average 51 per female. Females live 56 and males 35 days. Pairing takes place on the fifth day after emergence and egg laying on the fourteenth day. Bailey (1939*a*) provides a useful summary of the bionomics and importance of the insect in California and mentions that Hodson noticed that it was associated with an odour.

XI. Summary.

British glasshouse Thysanoptera may be divided into two groups: (1) *Introduced Species*—with 13 recorded from glasshouses and six or more potential invaders from abroad; and (2) *Indigenous Species*—with 13 recorded from glasshouses and six potential invaders. Keys and illustrations are given for the adults. A general account of glasshouse thrips is followed by a detailed review of each species, including the common-name if available, important synonymy, references to literature in which adults and immature instars, anatomy or physiology, are described in detail, native country, geographical distribution including countries in which the species feeds in the open and/or under glass, distribution in the British Isles (including glasshouse history), species of plants attacked, nature and importance of damage, time of occurrence, habits, life-history, bionomics, tolerance to temperature and humidity, transmission of virus diseases, predators and parasites and control.

XII. Acknowledgments.

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